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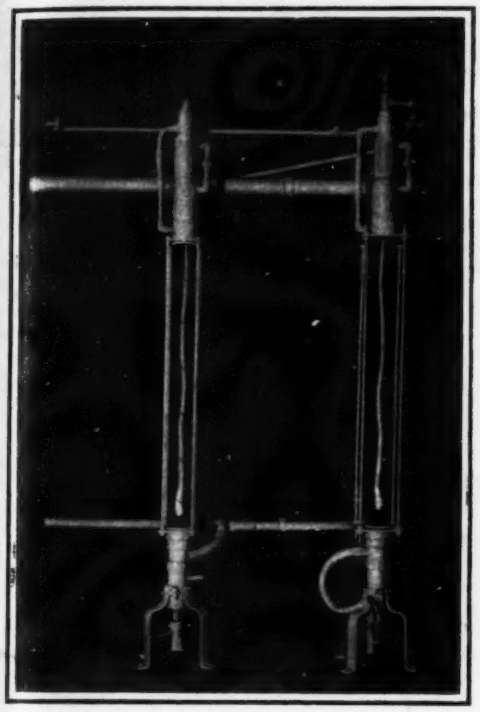
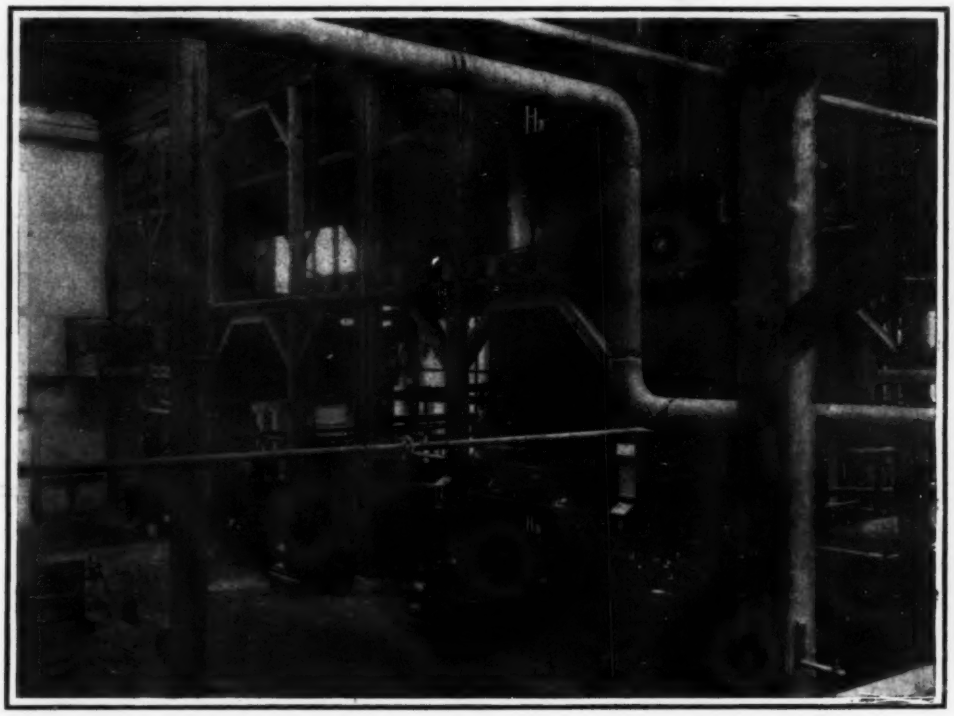
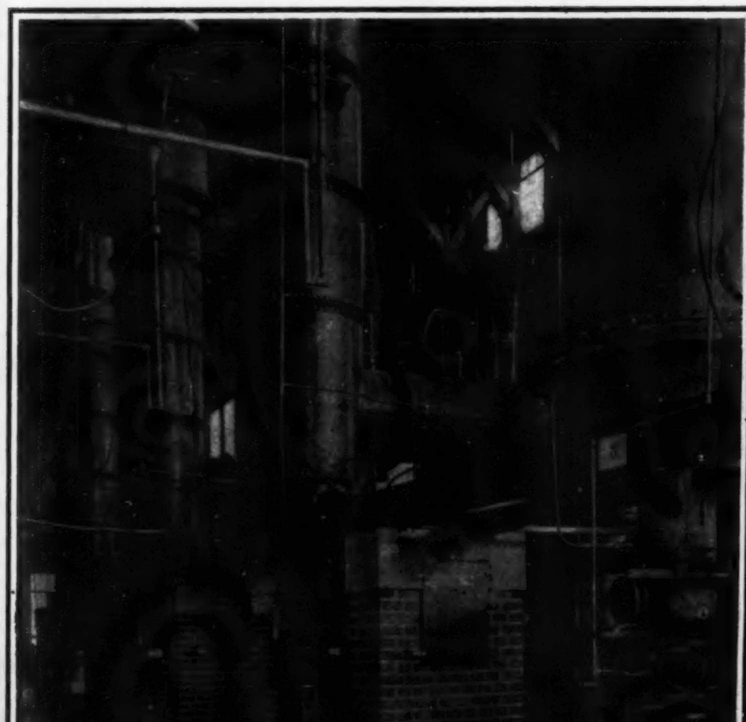


APPARATUS FOR DEMONSTRATING THE SCHÖNHERR PROCESS. NOTE THE UNDULATING FORM OF THE ARCS.



THE ABSORPTION ROOM AT KRISTIANSSAND WHERE THE SCHÖNHERR PROCESS IS IN ACTUAL USE.



BATTERY OF FURNACES AT KRISSTIANSAND.

LOWER PART OF THE FURNACE.

THE SCHÖNHERR PROCESS OF REDUCING ATMOSPHERIC NITROGEN.

THE REDUCTION OF ATMOSPHERIC NITROGEN.

THE SCHÖNHERR PROCESS.

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

The new process invented by Dr. Schönherr for obtaining nitrous products from atmospheric nitrogen is attracting considerable attention in Europe at present, as it appears to be an advance over the processes with which we are familiar. From a scientific standpoint it is of interest, for the reason that Dr. Schönherr produces an electric arc which is very long (in some cases over 20 feet). Such an arc is especially adapted to produce nitrous oxide from the air. The nitrous oxide is then used in the preparation of fertilizers. Dr. Schönherr's process is used in a large plant recently erected in Norway at Kristianssand in order to test the system in a practical way. Here there are erected three arc furnaces of 600 horse-power each, making a total of 1,800 horse power.

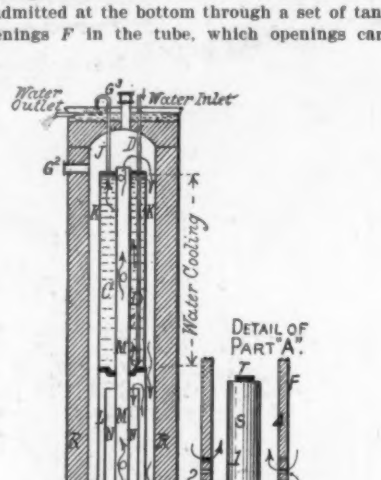
The working of this plant is now so successful that measures are being taken to operate the process on a still larger scale. The Baden Aniline and Soda Works of Ludwigshafen, who own the Schönherr process, have made an agreement with the Norwegian firm who are operating the Birkeland and Eyde process at Nottoden in order to construct water power plants to generate electricity for both processes. The enterprise includes the great Rjukan hydroelectric plant which is now building and which will use no less than 250,000 horse-power with a total head of water of 1,800 feet. The first half of the plant will have ten turbines of 15,000 horse-power each. In addition to the electric plant there will be operated a large nitrous product plant.

The Schönherr process is based on a series of researches made at the Badische Aniline establishment. Birkeland and Eyde use an arc former by alternating current between two electrodes, which arc is acted on by an electromagnet. By this arrangement the alternating current arc is blown by the magnet up and down alternately, so that it takes a vibratory movement and spreads out in a luminous disk as seen by the eye. The air is passed through the chamber containing the arc, and is reduced to nitric oxide.

Dr. Schönherr's method differs much from this. It was thought that such arc should always burn intermittently or, if not burned continually, that it should execute rapid vibrations in the air such as in the above-mentioned process. The inventor was, however, able to produce a steady arc of great length with a heavy alternating current. He forms a long arc in a tube, but were this arc not of a special character, the air current sent along the tube would be apt to extinguish the arc. Mr. Schönherr devised an ingenious way of sending the air through the tube without this possibility. The air is introduced at the bottom of the tube by a set of tangential holes, so that instead of blowing straight through the tube it takes a spiral or screw-thread movement, giving a gyratory motion of the air from bottom to top. The air which thus surrounds the arc does not blow it out, but on the contrary protects it from any contact with the sides of the tube. In this way the arc burns very steadily, even though an alternating current is used, and the arc may be located inside of a narrow metal tube.

Such an arc can be seen in our engraving, which shows a demonstrating apparatus. A glass tube is used to make the arc visible. An electrode is located at the bottom and top. Piping sends an air current from below in a gyratory movement. Both these tubes have the same kind of arc burning in them. The method of starting the arc is different, however. In the left-hand tube a spiral metallic strip is placed inside the tube from bottom to top. The arc starts at the bottom and runs up along the spiral until it reaches the top, when the long arc is then formed as here observed. In order to start the small arc at the bottom of the tube, a small spark-gap is left between the lower electrode and the spiral band so that the 5,000-volt alternating current can jump across the gap and start an arc. When such an arc is formed here the tension is sufficiently lowered so that there is no further passage of current at this point. After the arc has risen to the top it leaves the spiral and is now formed entirely between the bottom electrode and the upper metal head of the tube.

On the right is a similar tube which shows the method of starting the arc actually employed in the furnaces. In this case a temporary contact is made between the bottom and top electrodes by means of a fine metal wire in order to form an arc. A section of the commercial furnace is here shown. At the bottom is the main electrode which is formed of a heavy der of copper, cooled by circulating water. Th the cylinder is passed a movable iron rod T, the end of which is used as the actual electrode for the arc, so that this rod alone is worn by use. The wear is very slight and is inappreciable in a commercial plant. The iron rod is pushed up by hand from time to time in order to take up the wear. Under the action of the arc the iron is covered with a layer of magnetic oxide of iron in the fused state, and this is volatilized but slowly, for which reason there is no excessive burning of the iron. To start the arc in the first place the lever W is thrown which brings a metal rod temporarily in contact with the electrode. The arc then mounts up along the side of the metal tube M surrounding the interior and thus reaches the top. Air is admitted at the bottom through a set of tangential openings F in the tube, which openings can be



SECTION THROUGH A SCHÖNHERR FURNACE.

partially shut off by means of the sliding collar 3 so as to control the air flow. When the air enters by a single opening it passes up the tube in a screw-thread form, which causes the arc to be somewhat deviated laterally. This effect will be seen in the demonstration tube. The arc has a distinctly undulating form. In practice there are used a number of similar openings so as to give a very regular gyratory movement to the air, and the air current is better in this case. Observation shows that there is now no deformation of the arc and that it follows a straight line through the tube.

In the furnaces used at the Kristianssand plant which we illustrate here, the arc has a length of 16 feet for the 600 horse-power furnace, and for the more recent 1,000-horse-power type it has a length of less than 22 feet. The upper electrode is formed by the side of the metal tube itself, the surrounding tube being seen at MM. Such an arc can reach the top of the tube, or in other cases it is formed near it at a point where the gases are very highly heated and become conducting to some extent so that the current can now pass across. By means of the eye-pieces G_1 at the bottom and G_2 and G_3 at the top we can observe the working of the arc. Around the upper end of the arc tube is a cooling chamber cc by which the hot gases are suddenly cooled down to a much lower point. This quick cooling is essential for the good production of the nitric oxide. Water circulation is given at D and J. After leaving the upper end of the arc tube, the heated gases pass down in a concentric space KK inside the masonry of the furnace and pass down into the gas outlet a.

The fresh air enters the furnace at the lower inlet pipe b and first passes up through the concentric space L, it being heated in its passage by the gases which are leaving the furnace. At the top it changes its course and re-descends through the other concentric space N, passing along the outside of the arc tube so that it is further heated. Thus when it finally enters the tangential openings F of the arc tube it is already well heated, and this furthers the action within the arc tube.

The gases leaving the furnace consist of air and about 3 per cent of nitric oxide, such percentage, seemingly low, being in fact one of the highest yet obtained. Such hot gases are then passed through the tubes of a boiler in order to furnish steam for use in concentrating the nitrous products by evaporation. The nitric oxide changes to the reddish-brown nitrous oxide when cooled to 600 to 140 deg. C. To prepare the nitrates the gas is absorbed by soda or lime in suspension. By using lime there is formed a nitrate of lime which has a greater proportion of nitrogen than usual, and contains 18 per cent, while Chili saltpeter has but 15 per cent and the Nottoden product 13 per cent. The new product is therefore superior as a fertilizer.

RADIUM AND CANCER.

The Revue générale des Sciences of November 30th contains a lengthy and important article by Dr. Louis Wickham on the therapeutic action of radium on cancer, based upon observations made on 1,200 patients suffering from tumors, half of which are stated to have been malignant. Dr. Wickham himself has demonstrated recently in London and in Belfast the nature of the results he has obtained, and full reports are available in the Proceedings of the Royal Society of Medicine and in the British Medical Journal. Therefore there is no need to reproduce the details of the article. The illustrations in the Revue générale des Sciences are even more startling than those which have appeared in the English journals cited. The appearances presented before and after treatment are such as will, almost surely, carry conviction to all laymen, whether healthy or suffering from cancer, that radium can cure the disease. But Dr. Wickham does not write in a corresponding spirit of optimism. Indeed, the only note of triumph is the phrase "It is delightful to think that the whole evolution of radiotherapy (the marvelous discovery of radium by P. Curie and Mme. Curie, the construction of perfected apparatus, therapeutical applications) is almost entirely French." No one may grudge this full measure of recognition to the advances made possible in Paris, on the biological action of radium, by collaboration between laboratories of physics, chemistry, and pathology. Not the least measure of praise is due to Dr. Wickham himself, both for his initiative and for his achievements.

Persons who possess an intimate knowledge of the clinical course and pathology of cancer will be less impressed by the pictures of cured cases than by what Dr. Wickham writes and what he omits to refer to. The evidence of diagnosis and of microscopical structure is imperfect. The duration of the period of benefit after treatment, as well as the ultimate fate of the patients, are the criteria by which the success of surgery is measured; but the evidence advanced in Paris falls short of good standards in both respects. Dr. Wickham lays no claim to successful treatment of secondary deposits; he says severe cases ought only to be treated when the surgeon can do nothing, and that it is too early yet to say if radium is the means which ought always to be employed. A warning is given of the necessity for caution in appraising the value of any new treatment, and, above all, of the necessity of avoiding the risk of depriving patients of other treatment which has proved itself superior, especially of surgery.

The results obtained in Paris have attracted the attention of the world. The hopes they have aroused have awakened yet greater expectations for the future, when larger quantities of radium shall be available, and the technique better mastered. Meantime, notwithstanding Dr. Wickham's caution, the writer considers a further note of warning is necessary. All that is claimed for radium is a beneficial action when applied directly to primary growths. Secondary growths inaccessible to direct surgical removal are inaccessible to radium in consequence of the restricted penetration of the rays. Whether or not means will be devised for attacking deep secondary deposits—the very site of which it may be impossible to determine—remains to be seen. The actual injection of emanation solution has met with no success. Nor is the evidence that radium has a marked elective action for

cancer tissue so strong, at present, as to arouse any great hopes from more efficacious means of flooding the body with radio-activity. In short, radium does not appear to be nature's remedy for cancer, but an empirical remedy with the same shortcomings as all other such in the case of cancer, in that the local condition alone is attacked and the constitutional conditions are unassailable.

That the body can generate powers of its own, leading to constitutional changes which enable it to deal effectively with cancer, has been abundantly demonstrated by recent experiment. In given circumstances, 100 per cent of animals bearing transplanted tumors can cure themselves. The facts ascertained show that the natural forces of the body can cope both with secondary deposits and with primary growths. Though this process of natural cure is not, and may not speedily, be elucidated, still, it is not too sanguine an expectation to anticipate that ultimately it will be. The means for checking the ravages of cancer will be found, not by searching the surface of the earth for a vegetable remedy, nor the bowels of the earth for a mineral one, but by following the definite clue, that in the living body itself forces can be elicited which effectively combat the disease. Until that goal shall be attained, when surgery fails or is unavailable, relief may be sought, but cannot be guaranteed, by resorting to treatment with radium, the full possibilities of which have not yet been developed, even in Paris.—Nature.

THE CHEMISTRY OF INSANITY.

A CURIOUS THEORY.

Among the present wonders of science, none stirs the imagination, says The British Medical Journal, so powerfully as the doctrine that some forms of insanity are the result of a chemical change in the blood. The ill temper which we feel and make others feel, on a bleak east windy day or from want of sleep, or because our digestions are out of order; and every stage of drink, from the happy letting-free of thought and talk, to the reeling home and physical nastiness of the drunkard; and all the nightmares, all attacks of melancholy, all extravagances of passion—they are all due to a chemical change in the blood, acting on the brain.

But go even further back, we are bidden. Think of such cases as most of us, at one time or another, have known, or have watched or have been. Here is a case of typhoid fever, and, with other evidence of a change in the blood, such as a high temperature, a rash, pains in the bones and the like, comes delirium, and the patient babbles or raves.

Here is a case of influenza; the acute stage is past, but the patient is so odd, so dismal, worrying over his business, though he need not worry, and always saying that he ought to have done more for his wife and the children, and then one day he is lost and found dead by his own hand. Go further—here is a case of chronic alcoholism, here a case of puerperal mania, here a case of mania after some terrible shock. Chemistry, chemistry, all of them chemistry! Do we not brew, within ourselves, poisons which enter the circulation, and pervade every tissue of the body? What is the difference between a man talking nonsense under the influence of wine, or the influence of an anesthetic, and a man talking nonsense under the influence of the poison, the "toxins," of typhoid fever? Or take the instance of temporary insanity after shock. Do we not all know, from experience, how sudden terror, sudden bereavement, sudden happiness, can upset the functions of the body in a chemical way just as poisonous food upsets them, and shall the brain escape, and not be upset with the rest of the body?

This doctrine sweeps into its net a whole legion of cases. Other cases, at present, are outside the net. Cases where the whole life has been careful, temperate, chaste, and uneventful. Cases where heredity, and that alone, seems to have done the harm. Cases, for there are some fools who think of them as cases, of genius. Never mind at present what at present escapes the net. See what is taken in it. Was there ever such a haul?

Nobody can doubt for a moment that the doctrine of a chemical agent in many forms of insanity, a poison or poisons, a toxin or toxins, brewed within the body, has tight hold of truth. Nobody can doubt, either, that the treatment of some cases of insanity is likely, now or in the near future, to be advanced by work done on the lines of this doctrine, and on these lines alone.

As a matter of fact, this chemical explanation of insanity is not so new as it sounds. The substance of the doctrine may be found in old medical books, with their strange talk about gross and peccant humors, troubling the vital spirits. But, for exacter knowledge, the doctors had to wait for exacter methods. They could not formulate a chemical theory of insanity without the help of physiological chemistry; they could not formulate the chemistry of fever without the help of bacteriology, and for bacteriology they had to wait first for better microscopes and then for Pasteur. In every age the doctors have been as far forward as the age would let them go, and no opportunity was given them until now to advance to the ground which they are now beginning to hold.

But a special charge is laid against them in this matter. It is said that they have been, many of them, all along, on the same track, a wrong track. They have believed in mind as something wholly different from brain. They have clung to an old faith which is alien to science and has lost all influence over many schools of modern thought, that a man is not only a corporeal being, but also a spiritual being—free and in some way independent of his physical structure. All their ideas about insanity have been clouded and confused and blocked by this purely conventional notion of mind or self as real.

All along they have talked and written of insanity as a disease of the mind, not as a disease of the brain; and have treated it, in the old days with chains and strait-waistcoats, in later days with kindness and recreations, but never with chemistry. If only they had started thirty years ago with the plain truth that the brain secretes thought just as the liver secretes bile, what an infinite gift might now be in their hands, what a burden lifted from the world. If only they had worked at insanity as they have worked at diphtheria and myxœdema, should we not have by this time an antitoxin, or a tabloid of some organic extract, a sure and rapid cure? But they failed to grasp this simple fact that thoughts are merely the results of molecular changes in the gray matter of the brain.

Now, it is true that the doctors, many of them, have sinned in this way; and most that can be said to excuse them is this, that they have sinned in very good company. . . . They are opposed to the present tyranny of popular materialism. Let us see why. Popular materialism, roughly speaking, is the creed that free will, self, spiritual life, and all such words are merely the names of mental processes, and that mental processes are merely the results of cerebral processes. Whence it follows that if only one could get at the cerebral processes, get at them with exactitude, by drugs, or by hypnotism, or by surgery, one would get at the corresponding mental processes.

The old-fashioned doctor says, When we doctors can do that, do it with exactitude, do it with safety to the patient, and do it with a successful result, I shall be no less pleased than surprised. Or, to speak more accurately, I shall be in my grave long before that, and the pleasure and the surprise will come to doctors then living. Meanwhile, I must do my best with what resources I have. And I say this, that I, in my family practice, would be hindered more than helped if I took the position of cock-sure materialism.

For one case of insanity the doctor sees twenty cases of those who are sane, yet betray some fault, some little instability, temporary or permanent, of the nervous system. They are sane, but each of them has, at times or always, his or her failing, a sort of faint image or haunting sense of some weakness which, nursed and fed up and stimulated, might grow to a dreadful size. Look at these cases, if they can be called cases; this multitude of men and women going about the day's work and the day's pleasuring, sane, useful members of society, but none of them up to the mark. Then, from them, look onward to those cases so terribly common at the present time, the legion of women, with some men among them, nearer the edge of danger; those whom the doctor used to call hysterical but now calls neurotic, but who call themselves by a host of pretty names—delicate, over-worked, dreadfully sensitive. Then look onward to the very danger edge, to the "border-land" cases, the poor folk who are just so insane that they cannot still be counted as sane. Then, and not till then, look over the edge.

The doctor, surveying this long crowd of his fellow-creatures, and conscious, doubtless, that he is no mere spectator but has a place himself somewhere in the line, sees no break anywhere, no sudden gap between perfect sanity and absolute insanity. It is evident that the doctrine of a chemical agent at work in some cases of insanity will not help the doctor here. He does not possess, and never will, a graduated series of antitoxins to treat all these people. A doctor running about with an antitoxin-syringe to cure ill temper, little eccentricities and slight attacks of the blues would be a monster, whom the State ought to catch and keep out of the way. You must be your own doctor. That is his message. You must cure yourself. No wonder that the doctor is a bit of a priest, for here is the old sermon that the will must be exercised.

To the vast multitude of neurotic women a word or two may humbly be said here, to induce them to see themselves as the doctor sees them. First, they must not think that the neurotic temperament is in any way an evidence of cleverness, or of good breeding, or of culture. Whatever it may be, it is not that. Nervousness is in no sense one of the accomplishments of the real lady; it never was and it never will be. Indeed, it is going the other way. Fifty years ago a woman might be neurotic and still be a lady. Now the doctor finds neurotic women mostly in the humble walks of life—among his patients at the hospital or at the dispensary even more often than in fashionable circles. . . .

Next, they must abhor, as the very devil, all secret use of drugs or of stimulants. Once started on that disastrous course they will go, as a dead certainty, from bad to worse.

Next, they must remember that they are spoiling other people's lives as well as their own. A neurotic woman is a bore.

What can she gain by her neurotic temperament? She has but one life. It might have been so much happier. The doctor does indeed pity her, but he has no antitoxin for her.

There is, to be sure, concludes our contemporary, one antitoxin. She must brew it within herself. It is a spiritual product, not chemical. To brew it many people have recourse to spiritual methods unknown to science. This heavenly antitoxin is what we call the power of the will.

HYDROGEN FOR BALLOONS.

The recent development of aeronautics has suddenly created a demand for large quantities of hydrogen at a low price. For supplying this demand France is at present laboring under great disadvantages in comparison with Germany, and even with Italy. In most cases the French military balloons are necessarily filled with hydrogen obtained by the old zinc and sulphuric acid process, and French aeronauts who purchase hydrogen are compelled to pay twice the price which this gas commands in Germany, where it is produced, in great quantities, as a by-product of the manufacture of soda by electrolysis. France possesses only one electrolytic soda works, but it is expected that the Claude process of producing hydrogen will soon be in practical operation. This process of fractional condensation was first applied to air, the products being pure nitrogen, highly oxygenated air and liquid oxygen. By applying the process to the impure mixture of hydrogen and carbon monoxide, which is known as water gas, and employing liquid air as a refrigerant, it is possible to separate and even to liquefy the hydrogen of the mixture. When developed on a practical scale the Claude process should furnish a cheap and copious supply of hydrogen, which could be compressed and transported in steel cylinders.

In regard to the manufacture of liquid hydrogen, which has been erroneously announced as being in commercial operation, it should be borne in mind that the necessity of employing intense cold will always make liquid hydrogen very costly. The employment of liquid hydrogen should, therefore, be restricted to small quantities, for use in emergencies.

Liquid hydrogen occupies only 1-800th the volume of the same quantity of gaseous hydrogen, at the standard pressure and temperature, and it can be vaporized conveniently and as rapidly or slowly as may be required, by the admission of measured quantities of air, which will liquefy and cause the evaporation of corresponding quantities of hydrogen. But, in addition to the cost of liquid hydrogen, which will always be high (except, possibly, in some districts abundantly provided with water power), there is the very delicate problem of transportation, which requires the employment of double-walled metallic vessels, and the maintenance of conditions which are difficult to realize in practice.

Hydrogen can also be obtained from water gas by another process, in which the other ingredients of the mixture (carbon monoxide, carbon dioxide and nitrogen) are absorbed by calcium carbide at a moderately elevated temperature. This process, according to its inventor, is quite practical, and furnishes a gas containing 99 per cent. of hydrogen, with traces of nitrogen and methane.—La Nature.

TALKING ELECTRICITY.

SPEAKING MAGNETS, SPEAKING IRON, SPEAKING WIRE.

BY EMIL KOSACK.

NEARLY half a century has elapsed since Philipp Reis first exhibited his apparatus for the electrical transmission of sound, to which he gave the name telephone. By means of this apparatus, which comprised a transmitter and a receiver, songs and instrumental music could be transmitted satisfactorily, but for the transmission of speech it required fundamental improvements, which were first developed chiefly in America and first assumed practical form in the Bell telephone. This instrument consists of a steel bar magnet, bearing at one end a small coil of wire, and an iron membrane stretched closely above the coil-bearing pole. When the coil is traversed by an electric current of rapidly fluctuating intensity, corresponding variations in the strength of the magnet and its attraction for the iron membrane are produced, so that the membrane is set into vibrations which generate sound waves in the air, and produce audible tones.

Another important stage in the development of the telephone is marked by the invention of the microphone, which is now employed universally as a telephonic transmitter. The essential part of the microphone is an electrical connection of varying resistance, formed by the loose contact of pieces of carbon, inserted in the circuit of a few galvanic cells. The resistance of the contact and, consequently, the strength of the electric current vary with the force with which the carbon surfaces are pressed together, and this force is sufficiently affected by the fluctuations of air pressure produced by speaking into the instrument to cause variations in the current, which correspond in every detail to the vibrations of the vocal sounds. Hence, if a Bell telephone is inserted in the same circuit, its membrane is forced to vibrate in a corresponding manner, and thus to reproduce the words spoken into the microphone.

In what follows we shall confine our attention to the receiving apparatus. The Bell telephone, in improved form, still remains almost the only practical telephonic receiver. In recent years, however, several other methods of translating the currents of the microphone into sound have been discovered. In 1898 Simon found that an electric lamp will reproduce words spoken into a microphone, if the vibratory microphone current is superimposed upon the uniform direct current which normally operates the lamp. This phenomenon is explained by the variations in the temperature of the arc, which are produced by the microphone current, and which are sufficient to cause vibrations in the surrounding air, which are perceived as sound. The microphone current is impressed upon the arc, not directly, but indirectly, by means of a small induction coil, or transformer, consisting of an iron core surrounded by two coils of insulated wire. One of these coils is inserted in the circuit of the microphone, the other in the circuit of the lamp. The fluctuating microphone current in the first coil generates, by induction, a similarly fluctuating current in the second coil, connected with the lamp.

Several experimenters with this apparatus observed that the telephonic reproduction of sounds sometimes took place when no luminous arc was formed, and traced the sounds to the transformer. The writer discovered that even the hissing sound which is occasionally produced by arc lamps was clearly audible in the transformer, placed in another room. As a transformer is essentially an electromagnet, it follows that every electromagnet and every permanent magnet can be made to sing and speak under the influence of a vibratory microphone current, which causes periodic changes in the magnetization of the iron or steel and thus produces molecular vibrations which generate sound waves in the surrounding air.

Peukert found that even the large masses of iron contained in dynamos can be thrown into audible vibration by the weak currents of the microphone, and constructed a telephonic receiver consisting merely of a closed horseshoe magnet, encircled at one point by a coil of wire connected with the microphone. The form of "speaking magnet" used in the writer's experiments is shown in Fig. 1. It is a straight bar electromagnet, energized by a direct current, but carrying also a small coil connected with a microphone.

The writer found, furthermore, that the magnet could be replaced by a simple core of ordinary unmagnetized iron. This change greatly weakens the action which, however, is greatly intensified by laying a thin plate of any material on the upper end of the core, as shown in Fig. 2. The plate takes part in the vibration and enables a roomful of persons to hear music played or sung before the microphone at the other end of the line. In this experiment the entire absence of the disagreeable crackling noises produced by the ordinary telephone was especially striking. This form of apparatus shows a certain resemblance to the old Reis telephone, in which, however, the iron is not in the form of a heavy bar, but in that of a thin wire, which is attached to a resonance chamber. From all these experiments it appears that a telephonic receiver can be constructed in the most primitive manner by inserting almost any coil of wire in the microphone circuit, slipping the coil over a hammer or other piece of iron, and attaching a plate of any material to the iron. Hence the iron membrane or vibrating plate of the Bell telephone is entirely superfluous. The writer has found by experiment that the construction can be still further simplified to a surprising degree. It is only necessary to apply to the ear a coil of wire connected with the microphone in order to hear faintly the sounds by which the microphone is operated (Fig. 3). Such a coil, consisting of a few yards of insulated copper or iron wire, is certainly the simplest form of telephonic receiver, but to give the instrument any practical value it is necessary to attach to the coil a plate of iron, brass or other metal, as is shown in Fig. 4. The metal plate intensifies the sound so greatly that when the instrument is applied to the ear words softly whispered into the microphone are distinctly audible. This apparatus differs from all forms of telephonic receiver now in use by the peculiarity that no iron need be used in its construction.

The action of this new telephonic receiver is explained by the well-known law of attraction between two parallel conductors traversed by electric currents flowing in the same direction. The individual windings of a coil of wire may be regarded as so many parallel conductors, which attract each other with a force which depends upon the strength of the microphone current which flows through them. As the fluctuations of this current correspond to the vibrations of the sound waves which act on the microphone, entirely similar vibrations are produced in the wire coil of the receiver and transmitted to the surrounding air, as sound waves, through the agency of the broad plate attached to the coil.—Translated for SCIENTIFIC AMERICAN SUPPLEMENT from Umschau.

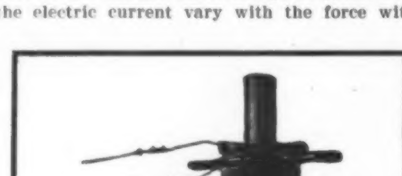


FIG. 1.—SPEAKING ELECTROMAGNET.

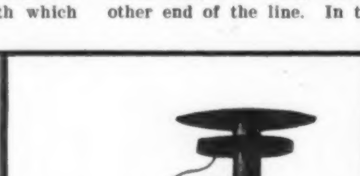


FIG. 2.—SPEAKING BAR OF IRON WITH SOUNDING BOARD.

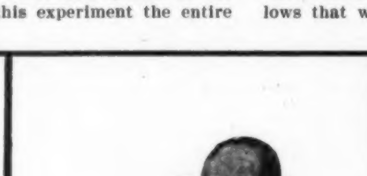


FIG. 3. SPEAKING COIL OF WIRE.

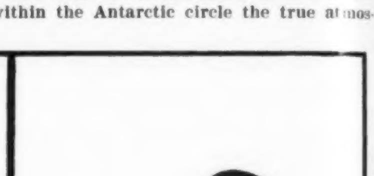


FIG. 4.—SPEAKING COIL OF WIRE WITH SOUNDING BOARD.

THE MEAN HEIGHT OF THE ANTARCTIC CONTINENT.

PROF. W. MEINARDUS gives the results of an estimate of the mean elevation of the central core of the Antarctic land mass, based on the distribution of atmospheric pressure and consequent exchange of air between the two hemispheres, in the November and December numbers of Petermann's Mitteilungen. Extending Spitaler's results with the help of Mohn's discussion of the "Fram" observations, and Baschin's maps of the southern oceans, Prof. Meinardus finds that, while the mean pressure (not reduced to sea-level) is 0.85 millimeter higher in January than in July between latitudes 0 deg. to 80 deg. N., in the zone 0 deg. to 50 deg. S. it is 2.14 millimeters lower. In higher southern latitudes, as far as 60 deg. S. lat., the January pressure is 0.73 millimeter less than the July, and from 60 deg. S. to the Antarctic circle the relation is almost one of equality. Hence, allowing for proportional areas, it follows that within the Antarctic circle the true atmospheric pressure must be 11 millimeters higher in January than in July.

Observation however has so far failed to reveal the existence of this excess; the diminution of the southward temperature gradient and consequent weakening of easterly winds on the edge of Antarctica in summer render it probable that, as in the north polar region, the pressure at sea-level is actually lower in summer than in winter. The discrepancy can be explained by assuming a mean elevation for the area within the Antarctic circle, and taking —3 deg. and — 26 deg. as the mean temperatures for January and July respectively, Prof. Meinardus gets a value for this of 1,328 meters, or, as a second approximation with temperatures —6 deg. and —29 deg., 1,350 meters, with a probable error of ±150 meters. Having regard to the proportion of the area known to be covered by sea, the land surface is taken as 14 millions of square kilometers (Bruce and Krümmel), and its mean height then becomes 2,000 meters, with a probable error of ± 200 meters.

Recent explorations suggest that this value is not far from the truth, the covering of inland ice being, as in Greenland, an important factor. If it is approximately correct, Antarctica is the largest mass of raised land in the world; it is half as large again as Europe, and Asia, the highest of the known continents, has a mean elevation of less than half (950 meters). The accepted value of the mean height of the land surface of the world, 700 meters, is raised to 825 meters, and the mean level of the physical surface of the globe from 205 to 240 meters.—Nature.

A fuel-testing plant is being established by the Canadian government for investigating the natural fuel supplies of the Dominion. As peat occurs in immense quantities in both Ontario and Quebec, an attempt is to be made to discover a method of using it successfully in gas-producers.

H. M. S. "LION."

HER PROBABLE APPEARANCE WHEN COMPLETE.

We venture to give an illustration of the "Lion" as she will appear when complete, if the published accounts are right. This vessel will be by far the most notable war vessel in the world. She will be about 700 feet long between perpendiculars and 86 feet 6 inches in beam. She will displace about 26,500 tons, and will be propelled by turbines of 70,000 shaft horsepower. Her speed will be probably not far short of 30 knots. Her armament will, following the all-big-gun principle, consist of eight 12-inch guns in four barbettes, and all will be placed on the center line. As her secondary armament she will probably carry sixteen 4-inch guns. On the whole she will probably be the most powerful vessel afloat when completed.

Unlike the "Orion," the "Lion" will probably have two tripod masts, and, in view of the fact that she carries no less than forty-two boilers, which have to burn coal enough to develop 70,000 horse-power, we have shown her with four funnels. It may be recalled in support of this that the "Mauretania" and her sister of approximately the same power have each four funnels, and that the "Invincibles," which develop only 40,000 horse-power, have three. Hence, even with four funnels, if the same cross-sectional area per unit is allowed, the "Lion" would be underfunneled. There is, moreover, the fact that the use of four uptakes permits a more convenient arrangement of the boiler-rooms; and, finally, that there is room for the four. The only argument against them is increased target area; but four funnels have been frequently employed in cruisers, and even six.—Engineer.

HIS MAJESTY'S FIRST-CLASS CRUISER "LION"—A FORECAST.

EXPERIMENTAL BOMBARDMENT OF THE "JENA."

THE RESULTS OF THE FRENCH FIRING TESTS.

Since the experimental bombardment of the "Belle Isle," of the British navy, at the commencement of the present century, no such thorough and systematic firing tests have been directed against a warship, in any foreign navy, as those of which the French warship "Jena" was the target last year. The numerous accidents which have befallen the French naval artillery in recent years, and in particular the unsatisfactory behavior of the ammunition when stored on board and in the firing tests of 1907-8, had seriously impaired the confidence of French naval officers in the efficiency and reliability of their chief weapon. A divergence of opinion in regard to projectiles had, furthermore, been created by the results of the Russo-Japanese war. The Szemenoff school demanded, even of the projectiles of the heaviest guns, an explosive action similar to that of the celebrated Japanese shells which wrought such havoc at Tsushima, while their opponents attached the chief importance to armor-piercing power, combined with the maximum explosive action that is consistent with great penetration. Hence a searching investigation appeared requisite, in order to restore confidence and to avoid mistakes in the ammunition of new warships. The "Jena," which had been seriously injured by an explosion in 1907, and was unfit for further service, was selected as the object of attack.

Despite the strict secrecy which the French navy has maintained in regard to the methods and results of the experiment, an approximate idea of the firing tests can be obtained from reports published in the French and English press.

The original intention was to begin the attack with non-explosive armor-piercing shells, fired from a distance of 3 miles or more, but the Chamber of Deputies made this impossible by striking off $10,000 from the appropriation of $120,000 which the Senate had voted for the experiments. An unusually great practical value is given to these firing tests by the fact that the object of attack was a comparatively modern warship. The "Jena" was launched in 1898. Her displacement is 12,100 metric tons. Her armor includes a waterline belt of Creusot cementation steel, varying in thickness from 12.6 inches amidships to 9.1 inches at the bow and stern; an upper belt, 7 feet high and from 3.1 to 4.7 inches thick, extending from the bow to within 100 feet of the stern; casemate armor 3.5 and 4 inches thick; a 2.6 inch protective deck; commander's turret 11.7 inches, great gun turrets 11.5 inches, and communicating galleries 8 inches thick. Her former armament comprised four 12-inch guns, mounted in turrets, eight 6.7-inch rapid-fire guns, protected by 4-inch shields in casemates separated by 1.2-inch partitions, eight 4 inch rapid-fire guns with 2.2-inch shields, and twenty 1.8-inch rapid-fire guns. This armament had been removed, but an obsolete heavy gun was placed in each turret and an old 6.5-inch gun in each casemate. The explosion in 1907 had injured the after part of the vessel and affected its flotation. The latter defect was remedied by filling some of the compartments with cork, and the ship was brought to her normal water line by the addition of ballast. The firing tests were confined to the forward and middle parts. Some of the casemates contained the regular supply of ammunition. The Germain apparatus for controlling vessel and gun fire was in place. The lighting system, as well as the apparatus for ventilation, to which particular attention was to be given on account of the danger from smoke and gas in battle, were in partial operation. Puppets, representing men, were distributed about the vessel, and dogs, pigeons, and rabbits were placed in the turrets and casemates, and in unprotected situations. At first microphones were attached to some of these animals, for the purpose of determining the effect produced on the action of the heart by explosions of shells, but the results obtained were so meager that the instruments were soon removed. The boats were left in their places and the bunkers of the part of the ship to which the attack was confined were filled with coal. Preparations were made for testing the utility of light armor around the smokestacks, the effect of shots on fireproofed wood, the combustibility of paints, etc.

The vessels detailed for the firing tests were the warship "Suffren" and the armored cruisers "Condé" and "Latouche-Tréville." The firing at long range, with which the experiments concluded, was done by the "Suffren" and the armored cruiser "Jules Michelet." These vessels carried guns of the following calibers and types:

Caliber in Inches.	Length in Calibers.	Model (Date).	Vessel.	Muzzle Velocity in Feet per Second.
12	40	1893-6	"Suffren"	2,673
7.6	50	1903	"Jules Michelet"	3,198
7.6	45	1893-6	"Condé"	2,755
7.6	45	1887	"Latouche-Tréville"	2,526
6.4	50	1902	"Jules Michelet"	3,116
6.4	45	1893-6	"Suffren," "Condé"	2,837
5.4	45	1887	"Latouche-Tréville"	2,509
3.9	55	1892	"Suffren," "Condé"	2,394

All of these, except the 12-inch, are rapid-fire guns.

The 9.4-inch, 50-caliber gun, model 1902-6, provided for ships of the "Danton" class, was represented by a 9.4-inch, 40-caliber gun, model 1893 (muzzle velocity 2,624 feet per second), mounted on a neighboring islet, on which were installed, also, for the experiments of the war department, a 9.4-inch, 28½-caliber gun, model 1881 (muzzle velocity 2,034 feet per second) for the discharge of the cresyt or "P" shells of the coast artillery, and a battery of 6.4-inch guns.

The following shells were provided for the firing tests: 183 12-inch, 77 9.4-inch, 16 7.6-inch, 106 6.4-inch, 32 3.9-inch, and 33 9.4-inch "P" shells. All of these, except the "P" shells, were made and charged specially at the Gavres arsenal. In the long range firing which concluded the experiments shells taken from the magazines of the "Suffren" and the "Jules Michelet" were used, but as a precaution against accident 60 similar shells were first discharged at the Gavres proving grounds.

As was mentioned above, the solution of the problem of ammunition was the principal object of the whole experiment. It had been decided to abandon the use of cast-iron shells (*obus en fonte*). Cast-iron shells charged with black powder had already been abandoned and the cast-iron shells charged with melinite, which constituted a large part of the ammunition of the older vessels, were regarded as unreliable, on account of the weakness of the wall of the shell and the resultant danger of bursting the gun. Steel shells of two types were in use: armor-piercing shells (*obus de rupture*), charged either with black powder or with 2 or 3 per cent of their weight of melinite, and semi-armor-piercing shells (*obus de semi-rupture*) charged with about 6 per cent of melinite.

The events of the Russo-Japanese war led to an agitation in favor of increasing the charge of high explosive to 10, or, if possible, 15 or 20 per cent of the weight of the projectile, even though this change should necessitate a considerable diminution of initial velocity. The naval administration, however, insisted on the necessity of high muzzle velocity, in view of the steady increase in range, and therefore regarded an increase of explosive charge, which involves a decrease in the thickness and strength of the shell, as impracticable. The administration also considered the chief function of heavy guns to be the penetration of armor and the destruction of the vital parts of the ship inside the armor. The explosive charge was calculated in accordance with these views and was fixed, for the new shells, at 3 per cent of their weight, while an absolute increase of the charge was effected by increasing the weight of the shell by about one-third. Thus was evolved the new standard shell (*obus alourdi*) for ships of the "Danton" class, which is 3.44 calibers long and is charged with 3 per cent of melinite. The new 12-inch shell weighs 968 pounds and contains 29 pounds of melinite (instead of the 748 pounds weight and 19 pounds charge formerly employed); the new 9.4-inch shell weighs 484 pounds and contains 14.3 pounds of melinite.

Another new projectile, constructed as an experiment, is an elongated 6.4-inch steel shell (*obus alourdi*), having a length of 4 calibers and a 10 per cent charge of melinite. The war department has gone still farther in this direction by supplying the 9.4-inch coast defense guns with the *obus P*, charged with 75

pounds, or 17 per cent of its weight, of cresyt. This shell is designed to be discharged with a low initial velocity (1,800 to 2,000 feet per second) against the parts below the water line. Former firing tests had caused it to be regarded as unfit for naval ammunition, because of the low initial velocity necessitated by the high charge of explosive.

Shells of all the types described above, except cast-iron shells charged with melinite, appear to have been discharged against the "Jena." They were ignited by retardation exploders, of various French and foreign makes, which were placed at the base of the projectile and operated by its rotation. The new Watson contact exploder, designed to operate on striking 1/6-inch plates, was used with some of the highly-charged elongated and "P" shells.

The firing tests were conducted, contrary to the original plan, chiefly at very short range, although five 12-inch and twenty smaller shells were finally discharged at long range. In general, the attacking vessel was anchored from 1,600 to 2,000 feet distant from the "Jena," and the firing charge was calculated to give the shell the same final velocity which would have been produced by a full charge at the distance of 20,000 feet, the long range mentioned above. As it was desired to hit, in each case, a predetermined small part of the ship, the greatest possible care was taken in aiming. In consequence of this, of the elaborate examinations made, and the numerous precautions observed, only from two to four shots were usually fired in a day. After aiming, the gunners abandoned the turret or casemate, and the gun was discharged electrically from a neighboring turret. The ship's company remained beneath the protective deck, the ammunition chambers were closed and the firing piece was completely isolated from the ammunition hoist and the magazine. Similar precautions were observed in the discharge of the "P" shells by the land battery.

Each shell was photographed as it left the gun and as it struck the "Jena," and after each shot a new diagram of the "Jena" was made, on which each hit was marked in white, red or green, according to the size of the shell.

The first series of experiments was conducted in August and September by the armored cruisers "Condé" and "Latouche Tréville," with 7.6, 6.4 and 3.9-inch shells of which only the largest were used against heavy armor. An attack of the land batteries, in September and October, was cut short by the sinking of the bow of the "Jena" by a 9.4-inch shell. The leak was stopped and during three weeks the "Suffren" attacked every armored part of the "Jena" with the new standard and other 12-inch shells. A delay of four days was caused by the damage inflicted by one of these shots.

In November the superstructure was attacked, from land, with 9.4-inch "P" shells. The firing tests at long range followed, and the experiments concluded, in the latter part of the month, with tests of the Watson exploder, attached to five 6.4-inch and six 9.4-inch shells. According to French journals, more than 300 shells, of all calibers, were fired at the "Jena." The experiments were terminated by the exhaustion of the appropriation. They cannot be resumed very soon, as the ill-fated vessel was wrecked by a storm in December, and sank in five fathoms of water.

In regard to the results of the experiments, the accounts given by French newspapers and technical journals are incomplete and not entirely accordant, but we will attempt to select, chiefly from Le Moniteur de la Flotte, La Vie Maritime et Fluviale, and Le Yacht, the most probable data, for criticism and comment.

The cast-iron shells charged with black powder appear to have made very large holes in the plates of the "Jena," owing to the great number of fragments produced on explosion.

As no report of the behavior of cast-iron shells charged with melinite is published, it may be inferred that these shells, which had already been condemned in principle, were not used, in order to avert, as far as possible, all danger of bursting a gun, as such an accident would have been a serious obstacle to the restoration of confidence, which was one of the main objects of the experiment.

The armor-piercing shells charged with black powder showed good penetrating qualities, but the small number of their fragments—five at most—made their subsequent destructive effects unsatisfactory.

The armor-piercing shells containing 2 or 3 per cent of melinite, bursting into a much larger number of pieces, produced a correspondingly greater effect inside the armor, which they were equally successful in penetrating.

The excellent performance of the semi-armor-piercing shells, containing a 6 per cent charge of melinite, is emphasized in all of the reports. They easily penetrated armor of a thickness greater than half their diameter, and, even when striking at an angle of 40 degrees to the normal, they showed very good armor-piercing qualities. In exploding, they caused remarkable destruction.

The new standard shells (*obus alourdis*) charged with 3 per cent of melinite likewise gave very good results. Although an English report states that the 12-inch shells failed to penetrate the 12.6-inch amidship armor of the "Jena," a French journal regards as proved their ability to penetrate, in normal conditions and at a range of 40,000 feet, cementation steel armor of a thickness equal to their diameter. The retardation exploder worked perfectly, so that the shell always passed completely through the armor before exploding, and the explosion produced astonishing effects. The Vie Maritime mentions a rumor that some of these shells turned over in the air, but according to the Moniteur de la Flotte the *obus alourdi* has thoroughly proved its usefulness and requires only some improvement in detail.

The elongated shell containing 10 per cent of melinite (*obus allongés*) which were designed for the guns of medium caliber of the vessels in course of construction, apparently failed to fulfill the hopes entertained of them. At least, they did not produce the fearful havoc described in Szemenoff's account of the naval battle at Tsushima. They were shattered against heavy armor and exerted no destructive action. They penetrated thin plates, but the centrifugal exploder came into action too late. Armor of medium thickness caused them to explode, but no destructive effect was produced behind the armor. The new Watson exploder was probably designed especially for these projectiles, when used against the superstructure and other unprotected parts, but no report of the performance of this device has been published.

The "P" shells of the coast artillery, charged with 17 per cent, or 75 pounds, of cresyt, also proved unsatisfactory for similar reasons.

These experiments appear to prove that thin armor, which can be pierced by shells of medium caliber, is worse than useless. It causes the shell to explode, and thus spreads destruction behind it. It follows that, instead of making the thickness of armor equal to the caliber of the guns behind it, all vital parts, including the intermediate battery, should be protected by heavy armor. In order to assure sufficient penetration, the explosive charge of shells of medium caliber should not exceed 7 per cent of their weight. This is, approximately, the charge of the semi-armor-piercing shells used in these experiments, which proved that armor-piercing power is very greatly diminished by increasing the charge of explosive from 5 per cent to 10 per cent of the weight of the projectile.

The explosive action of the armor-piercing shells of all types proved eminently satisfactory and the Vie Maritime and other journals concede that the explosive charges demanded by many French technicians are excessive, as the effect produced behind the armor depends more on the armor-piercing power than on the quantity of explosive. Szemenoff's description of the tremendous havoc wrought by the Japanese shells is regarded as an exaggeration. The retardation exploders used in most of the experiments worked excellently in connection with armor-piercing projectiles, but they proved to be insufficiently sensitive for the shells employed against unprotected parts, and especially for shells with very high charges of explosive. For such uses better results are expected from the very sensitive Watson contact exploder.

According to some reports no fires were caused by the explosion of melinite shells. As the melinite shells used in the French army do cause fires, this statement suggested the question whether this negative result was due to the character of the exploder or to the fact that the melinite was poured into the naval shells in liquid form. According to other reports, however, a 6.4-inch shell, which struck a turret of the "Jena," started a conflagration which kept the turret red hot for an hour, and a 7.6-inch shell fired the ammunition in a casemate. The last-mentioned occurrence leads some critics to demand the removal of the emergency ammunition from the casemates, but Le Yacht advises its retention at the commencement of an engagement, when a rapidity of firing is demanded with which the apparatus for conveying ammunition from the magazine is utterly unable to cope. This journal adds that adequate protection against fire can be secured by a well-organized system of extinguishing fire and the removal of all combustible materials, and expresses the opinion that the numerous fires and suffocating smoke experienced by the Russian ships in the war with Japan were caused chiefly by the distribution of coal throughout the entire vessel.

In most cases the animals confined on the "Jena" escaped unharmed, unless they were struck or burned by exploding shells. Examination of the blood of those that were killed showed that death was caused by wounds, and not by poisoning with explosion gases. The "bombardment with carbonic oxide," described in reports of the Russo-Japanese war, was not manifested in the French experiments.

From all accounts the damage sustained by the "Jena" was chiefly internal and not conspicuous from without, as the holes were little larger than the shells. This statement includes the holes made by the very highly-charged shells, when used with retardation exploders. The results of the experiments with the Watson contact exploder are not known. Le Yacht asserts, however, that the casemates and turrets were seriously injured.

Especially worthy of note is the statement that the apparatus for communication between different parts of the ship was made inoperative by the shocks caused by the first hits. A shot which struck the lower part of the armor belt broke electric wires on the third deck above. Hence it is of the utmost importance to fire the first shot, and it is also desirable to train the gunners to independent action, so that they can dispense with directions in an emergency. The steam and other pipes were greatly damaged by shock, which also loosened many rivets in the frames of the ship.

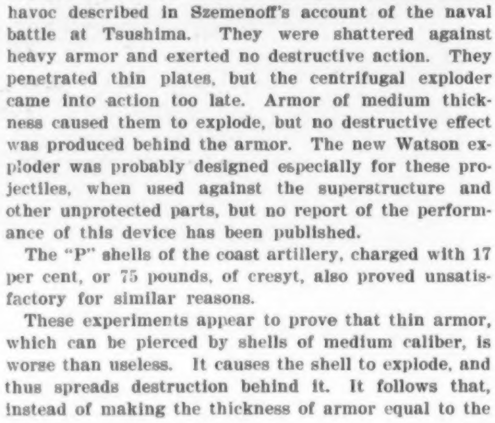
So far as is known, no accident occurred during these firing tests. This fact is very properly acclaimed by the French journals as one of the most important and gratifying results of the experiment, because it will restore the confidence in the guns and ammunition which had been seriously impaired by the frequent accidents of recent years. The semi-armor-piercing shells containing 6 per cent of melinite, and even the new shells with 10 per cent of melinite, may now be regarded as safe.

The lessons of the experiment will be applied at once to the armament of the projected warships, each of which will have a main battery of twelve 12-inch guns mounted in double turrets, and using the new standard shell (*obus alourdi*), and a secondary battery of eighteen 5.5-inch rapid-fire guns. The secondary battery is designed to ward off nocturnal attacks by torpedo boats, and also to demoralize the enemy in battle by their rapidity of fire and to injure vital and vulnerable parts by chance hits. The armor of all important parts of the new ships will also be increased, in accordance with the results of the firing tests, although not to the degree first contemplated. In order to avoid too great increase in displacement, the parts requiring protection will be concentrated as closely as possible. The secondary battery will be mounted in a central casemate with 8.7-inch walls, which will also protect the smokestacks.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Marine Rundschau.

A HOME-MADE ENGINE STOP.

By EDWARD T. BINNS.

SOME time ago the writer happened to be in the engine room of a manufacturing plant, when his attention was attracted to a rather ingenious device in the way of a home-made engine stop. The engineer explained that from some cause the engine had run away several times and in each instance disaster was narrowly averted. Accordingly, he had set about to produce an automatic engine stop at small cost. The accompanying sketch gives an idea of his apparatus. It is reported to have fulfilled its function faithfully several times.



A HOME-MADE ENGINE STOP.

There is a detachable drum fastened to the throttle of the engine with enough sash cord wound on it to correspond with the threads on the stem of the valve. The cord is run over pulleys and connected with a weight of sufficient size to unwind the cord from the drum as it descends, thus closing the throttle. Ordinarily the cord is wound on the drum and the weight suspended at sufficient height entirely to shut off steam in its descent. The drum comes off for starting and stopping and is placed on a hook out of the way.

The scheme for releasing the weight is that of a sliding bar, one end of which is caught under a pin in one edge of the pulley directly over the weight. As it is barely caught, an endwise movement of ½ inch will release the weight. The other end of the bar is connected to the upper end of a bell crank which is hinged at the elbow. The longitudinal arm of the bell crank is in contact with the stem of an ordinary flyball governor, which in turn is connected by a belt to the engine shaft. The stud of this governor is adjusted so that it will not act until the engine has reached a speed beyond the range of the regular governor, at which time the stem is passed downward, causing the weight to be released and a prompt shut-down is the result.—Power and the Engineer.

THE ARTIFICIAL SILK INDUSTRY.—I.

CONVERTING WOOD INTO SILKEN FABRIC.

BY W. P. DREAPER, F.I.C.

IN the French Exhibition of 1889 Count de Chardonnet exhibited his now well-known process of manufacturing filaments of nitrocellulose by squirting collodion under suitable conditions into the air. The progress from this early production of highly inflammable filaments to the present production of the large output of artificial silk manufactured by this process, which exhibits none of these inflammable properties, and resists the disintegrating action of water has been achieved by careful research. To-day the production of the material by the original method, starting with a solution of guncotton, has met with signal success; and even in the absence of any competing process would have led to the building up an industry of a permanent nature, from which the textile industry generally would have derived much benefit. This process of manufacture may in time go the way of most original processes, and give way to the more direct methods of later date. At present it is responsible for about 50 per cent of the world's output. I have been informed in the Elberfeld-Barmen district, where 500,000 kilos are worked up every year, that for some manufactures the nitro-product is absolutely essential, while for others the newer products are of more value. If time proves that this is a normal condition, then the mere cost of production will not be the only determining factor in the situation.

Any way it is patent to all those interested that great economies have been effected in this process, more especially in the recovery of the solvents, and their re-use; in the rapidity of production; and in other ways of which no one outside the actual works can have definite knowledge.

Of the processes which have survived to this industrial stage, the three systems called, respectively, the nitrocellulose, the cuproammonium, and the viscose ones may be specially mentioned. These have been so controlled, that they now produce a marketable product, which is in such demand that delivery can only be obtained for the second half of next year at the earliest. This latter point is an important one, for it is an indication that the newly-founded industry is based on a genuine demand.

These yarns, which range in size from 100 deniers upward, are not adapted to the manufacture of such materials as are prepared from ordinary silk fibers of from 15 to 32 deniers, or even upward; but they enter into a whole range of articles, and have had a profound influence on certain manufactures, such as the braid industry, and given employment to a large number of hands. The new uses which are being found almost daily for these products also indicate a steady and increasing demand for the yarns in the future. For example, it is possible to manufacture a heavy cloth from these high denier yarns.

The early samples of the nitrocellulose product were extremely brittle and inflammable, and lost 50—70 per cent. of their strength on wetting. They were, however, extremely brilliant, and this satisfactory factor certainly led to further research and improvements in other directions, which gradually decreasing these objectionable features, caused such a demand for the yarn in comparison to the possible supply, that the price of this artificial silk for a time actually exceeded that of the real material. The extreme brightness of the goods made from it, and their peculiar feel, was undoubtedly the cause of this. With this state of affairs there is no wonder that the industry in France and Germany expanded, and several companies were undoubtedly formed to work processes which had little chance of commercial prosperity. The patent list of these times also indicated the gradual expansion of the experimental work which naturally followed, and was destined to give to these countries an absolute monopoly of manufacturing, which they have held to all purpose until the last year or so; and also to give to the textile manufacturers of these countries a first call on this important and novel product. The absence of the yarn itself in this country was one of the chief factors causing our neglect of this matter. The many difficulties of the process were emphasized by the failure of the English company (starting to manufacture under the Chardonnet rights) due, it was then said, to local atmospheric conditions, the actual solution prepared in France refusing to spin at the Coventry factory.

Dr. Lehner demonstrated his process in London, but it was in Switzerland that he built up the enormous business which is associated with his name, and which to-day turns out such large quantities of the nitro-product. Chardonnet had to work with very high pressures, but Lehner, by modification of the solution, was able to squirt at very low ones. He also squirted into water, and in this way recovered the major portion of the solvent. The threads of nitrocellulose were wound on to bobbins and dried.

Factories producing such a product were destined, sooner or later, to come under the notice of the insurance companies. Serious fires took place, and were unpreventable. It was found that the nitrocellulose yarn in the dry state, like silk, became highly charged with electricity, and that self-ignition took place. The risks were subsequently modified by keeping the yarn in a wet state until it entered the "denitrifying" bath. There was still the alcohol-ether to be reckoned with, and it is, I believe, still impossible to insure such a factory. This mattered little, however, to companies making such profits. The Tubize Company rebuilt part of its factory a few years ago out of the year's income and still paid a good dividend.

Great speculation in shares; high and fluctuating prices for the yarn; fire at the works—but, most important of all, an increasing demand for the product, characterized the early days of the industry, the slow and steady progress of which was assured and never in doubt.

HISTORY OF THE INDUSTRY.

In 1855 the well-known French investigator Reaumur suggested the production of what might be termed artificial silk, and in 1885 Andemars patented the production from a nitrocellulose base, but nothing more was heard of the process. In 1884 Count de Chardonnet deposited with the Academie des Sciences a sealed document which was opened on November 7, 1887; it bore the title "Sur une matiére textile artificielle ressemblant à la soie." He had sufficiently worked out his process of manufacture to obtain a Grand Prix at the Paris Exhibition in 1889 for his product. He lodged his first patent on November 17, 1884 (Fr. Pat. 165,349). The first apparatus actually used for trials is shown in a photograph published in a work published by T. Foltzer in 1903 (Fabrication de la soie artificielle parisienne).

In 1889 Du Vivier produced a product termed "Soie de France," but except in small details the production, and product, was very similar to that of Chardonnet. In 1892 Lehner patented his modification of the Chardonnet process (Fr. Pat. 221,901, May 25, 1892).

As a result of these early inventions the following centers have produced this nitrocellulose product in large quantities. Works at Besancon in France; at Tubize and Droopgenbosch-Ruysbroeck, in Belgium; at the four factories of the Vereinigte Kunstseide Fabriken, of Frankfort; at Kelsterbach S.M., at Robingen near Augsburg; Glattbrugg and Spreitenbach, near Zurich; at Padua in Italy, and in Hungary.

The first patent connected with the production of artificial silk from cellulose dissolved in a cupro-ammonia solution was that of Despeissis (Fr. Pat. 203,741, Feb. 12, 1890). The only remaining record of this appears in a French publication, as under the French law of that date the specification was not printed, and being abandoned, owing, I believe, to the untimely death of this investigator, is not available for reference. Nothing more was heard of this process until Pauly in 1897 patented a process on very similar lines. The English specification has since been restricted by amendment so that the original suggestion of Despeissis, viz., the addition of a proportion of some albuminoid substance to the solution, has been omitted in the latter specification. In 1899 (Eng. Pat. 6556, 1899), Fremery and Urban took out their first patent, dealing with details in the manufacture. In the same year (Eng. Pat. 18,260, 1899), Bronnert patented his first improvement in connection with the direct solution of cellulose, although he had previously, in 1886 (Eng. Pat. 6858) taken out a patent for improvements connected with the nitrocellulose process.

Pauly, Bronnert, Fremery, and Urban are for ever associated with the industrial application of the copper-ammonia process on the large scale; they have through their investigations led to the development of the celebrated Glanzstoff Company, which to-day employs over 7,000 hands, and manufactures such large quantities of this product. Its headquarters are at Elberfeld, and works at Niedermorschweiler and Oberbruck in Germany, and it is also interested in work at Givet, and at Izieux, in France (Messi Gillet et Fils). I believe that a Spanish company, t Sociedad Espanola de seda Parisien, has ceased wor ing. The British Glanzstoff Co., Ltd., has recent started works at Flint, which, it is said, will gi ultimately employment to 2,000 hands. It is und stood also that works will shortly be erected in Russ

In 1902 Thiele took out his first patent for impro ments which enabled much finer filaments to be sp than heretofore. This and subsequent patents su gested a possible development in the industry (I Pat. 320,446) in competition with the natural artic

Since that date the patents registered in connecti with this copper-ammonia process have been ve numerous. Only time will demonstrate their resp tive merits. In some cases copper carbonate in a monia is used to dissolve the cellulose. Many pater deal with the use of different precipitating solutio and details in the process, such as, for instance, t preliminary mercerizing of the cotton.

In the early days there were in this country seve investigators of note working on the subject of ar ficial filaments, amongst whom may be mention Crookes, Swinburne, Wynne and Powell, and Swa also the first patent for a direct process of manuf turing from allulose was taken out by two Engli men in 1884. It was not until six years after t date that Despeissis took out his first patent, whi formed the basis for the early working of the cuproa monium process. It remained for France and G many to bring this industry to a successful iss However, having recently reached a state of manuf turing efficiency, as at the Coventry Viscose Wor we have made up for lost time.

It was natural that France, with the silkworm dustry so firmly established in the South, should lo with greater interest upon the possible manufact of an artificial product, which might supplement natural supply. The fact that Pasteur was inst mental in saving that industry from decay may a have had an influence in intensifying the belief t the problem was capable of commercial realizati through the aid of scientific research.

(To be continued.)

* Paper read before the Society of Chemical Industry and published in its Journal.

THE BAT.

THE small brown bat (*Vespertilio subulatu* despite its unpopularity, is a creature not devoid interest. It is hoped that the following observati recently made upon a live specimen of this anin may be worth mentioning.

The most noticeable characteristic about the anin was the peculiar, stale odor which accompanied Another equally unpleasant characteristic was t fact, disclosed by an examination of its fur, that was quite numerously populated by a species of lou The respiration of the animal was plainly visi and the average number of counts, when the anin was in a state of repose, gave as a result 160 respi tions per minute. Naturally, the respiration s gested the taking of the animal's pulse. This at fi seemed difficult to do, but the problem was sol when the observer bethought himself of a stethosc that happened to be available. This was one of "telephonic" type of instrument, the diaphragm be connected with the ears of the experimenter by t rubber tubes. The bat was placed in a Mason j over the mouth of which was tied a paper cover. T jar was now inverted and placed upon the diaphra of the stethoscope, so that there was nothing betw the bat and the instrument except a thin layer paper. The heart beat of the little creature was n plainly heard, but was far too rapid to be count In order to estimate the number of beats it v necessary to catch the rhythm of the heart beat tapping alternately with the two hands upon table, counting the taps of one hand only, and do ling. This gave as the result an average of 448 he beats per minute. This is approximately three ti the number of respirations per minute. The rate respiration and heart beat was very much influen by the nervous condition of the creature. Before e trial it was necessary to wait some little time, w everything quiet, until the frightened animal beca composed.

Cement for Repairing Hard Rubber or Vulcanit This is a mixture of molten guttapercha and natu asphalt, and is applied hot. The hard rubber arti must be kept pressed together till the cement co

THE GREAT DOLMEN OF BISCEGLIE.

INTERESTING RELICS OF PREHISTORIC MAN.

One of the most important events of recent years in .e field of prehistoric archæology is the discovery on ugust 6th in Bisceglie of a megalithic monument of :markable size.

This great dolmen was found by the well-known alian antiquarian Senator Mosso. Prof. Mosso had nceived the idea of excavating the prehistoric site Pulo di Molfetta. Accompanied by Don Francesco ımarelli he made three expeditions into the interior Molfetta with the object of searching for traces of olithic villages, like those of the neolithic necropoli Pulo, previously discovered by him. A laborer one ıy informed Samarelli that a sort of stone hut existed the bottom of his employer's farm.

Investigation of the man's statement led to the findg of this remarkable monument.

The dolmen is situated at a distance from Pulo about one and one-half hours ride by carriage, being st 6 kilometers from Bisceglie, on the road which ıds to Ruvo, on an estate belonging to Signora ıcietta Benaducci Pasquale, opposite "la Chianca."

This dialect term, meaning "the table," doubtless ıs derived from the principal part of the monument, ·d is indeed an equivalent of the Celtic word "dol-ɜn," used in Lower Brittany, which signifies "table stone."

Dolmens are classed among megalithic monuments, d have usually the form of a chamber with sides d a roof formed by huge stones, though sometimes ey seem to be natural caverns (*nicoveri*) without les.

In France about four thousand such monuments ist, none of them, however, being comparable in :e or beauty to this one of Bisceglie.

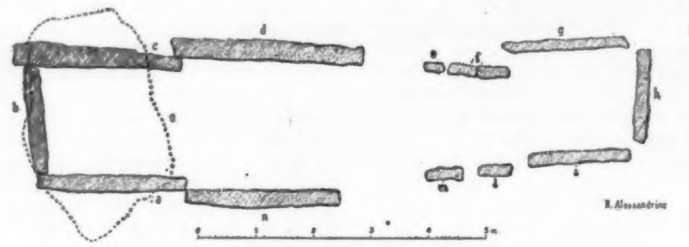
As shown in the accompanying diagram, a quadngular cell is made by the three huge stones, *a*, *b*, *c*, o forming the sides and one the floor, while a fourth d larger stone, *d*, serves as the roof.

The opening of the cavity is toward the east. The ınes, excavated on the spot, are placed with the ıoothed side on a pavement of the living rock and ɜ held erect by their own weight and the strength contact.

The left side has at the top two nearly circular ertures, which would appear from their contour be due to natural causes. Such apertures, however, ɛ a general feature of Celtic tombs, and considered archæologists to be designed for the ingress of the ıl.

Of the two sides, one measures 3 meters in depth 2.10 meters in height. The other measures 2.50 must originally have been covered, but at present all the stones are overthrown with the exception of the two adjoining the cavity. Of these, *d* at the right is 3.10 meters long. Before excavation the monument stood 1.65 meters high and was imbedded to a depth of 55 centimeters.

Within it were found human bones, including those of youths and adults. There were also various fragments of vases; a portion of a necklace of well-baked clay in the form of two truncated heptagonal pyramids united at the base; a flint stone of pyramidal shape, pierced by a hole for suspending it, perhaps as an amulet; a flint stone rounded like a hammer; a chip



PLAN OF THE BISCEGLIE DOLMEN.

or splinter of flint; and finally various bones of oxen, mingled with ashes and charcoal, doubtless the remains of funeral banquets consumed in honor of the dead.

The skeletons were in disorder and confusion, with the exception of two pairs of legs crossed at the knees.

By analogy with similar monuments it might appear that the corridor formed merely a vestibule to the sepulchral chamber, but on digging at its opposite end the remains of three dolichocephalic skeletons were found with more fragments of vessels.

It is evidence, moreover, that the narrow end turned toward the east, where we conceive the entrance to be, was closed by a stone, of which the lower part, imbedded in the earth, has been preserved. Consequently ingress to the tomb must have been through one of the two long sides.

The reader will be enabled to form an estimate of the unique importance of this monument by a mere statement in regard to the similar antiquities previously known.

A single dolmen of Corsica measures 1.38 meters in height. None of those of Lecce exceeds a meter; in most of them the sides which sustain the roof are not monoliths, but are composed of a number of smaller stones placed one on top of the other. In none of them is found the dromos or corridor. In none of them have been found skeletons with corresponding utensils.

Hence, we may affirm that the Bisceglie dolmen is the largest, the most perfect, of the ancient monuments of Italy, and one of the most beautiful and interesting in Europe.

For many centuries popular fancy has designated these monuments as the homes of fairies, giants or devils, or as the retreats of legendary heroes such as Roland or Gargantua. During a revival of heathen idolatry in the middle ages, they became objects of reverence, and as such were anathematized by the Catholic church, and many were destroyed in consequence of an edict of Charlemagne.

Dolmens previously known in Italy are found in the Terra d'Otranto, scattered along the shores from Castro to Otranto; four at Giurdignano; two at Minnervino; one at Palmarigi; two others at Lencasfride, and at Ricettulla, near Taranti, discovered last year by Prof. Mosso, but none so large as this of Bisceglie.

Except in India and Syria dolmens are found distributed over a long uninterrupted strip of territory, which, excluding Egypt, traverses Northern Africa, crosses the Strait of Gibraltar, and by way of the Iberian Peninsula, France, and the low countries, extends finally along the southern coasts of the British Isles and Scandinavia. No dolmens are known in Northern Italy, in Switzerland, in Southern and Central Germany, in Austria-Hungary, or in Russia, except a few on the shores of the Black Sea.

It is thus evident that a current of civilization from the Orient propagated itself along the southern coast of the Mediterranean and in Western and Northern Europe, and that another current of civilization, perhaps likewise of Oriental origin, but which marched to conquest by ascending the sources of the Danube, checked its spread in Central Europe.—Condensed for the Scientific American Supplement, from L'Illustrazione Italiana.

S GREAT DOLMEN WAS DISCOVERED BY MOSSO LAST YEAR. IT IS A HUGE MEGALITHIC MONUMENT OF CELLULAR CONSTRUCTION, BUILT IN PREHISTORIC TIMES.

THE GREAT DOLMEN OF BISCEGLIE.

ers by 2.12 meters. The bottom stone has the ensions 1.95 meters by 2.05 meters. The top stone 1.95 meters long by 2.40 meters wide, and varies n 0.25 meter to 0.43 meter in thickness.

corridor or "dromos" leading from the cavity 7.80 meters long and 2.30 meters wide near the ity and 1.70 meters wide at its farther extremity. he stones, *d*, *e*, *f*, *g*, *h*, *i*, *l*, *m*, *n*, deeply imded in the earth, form its outline. This corridor

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According to Electrical Engineering, rules have been issued to the effect that no apparatus for wireless telegraphy on board merchant ships, whether British or foreign, shall be used while in any of the harbors of Gibraltar, except with the written permission of the governor. The making or answering of signals of distress is excepted. The bill requiring all steamers to be equipped with wireless apparatus, which was introduced in the Canadian Parliament, has been shelved for the present, for the reason, it is said, of seeing what steps the British government is taking in this direction.

FALCONRY IN THE MIDDLE AGES.

THE SPORT OF KINGS AND THE KING OF SPORTS.

BY DR. HANS BOLLMER.

In the middle ages falconry, or hawking, was regarded as the king of sports, as it was the sport of kings. It is one of the oldest forms of hunting, and its origin has been traced back to ancient nomadic tribes of Central Asia, by whose descendants it is still held in high esteem. According to a Greek myth, King Demetrius was the first to hunt with the falcon, the sacred bird of Apollo. In Egypt divine honors were paid to falcons and the god Osiris was depicted with a falcon's head. Falcons were believed to cure disease, to live 700 years and to possess the power of prophecy after their death. According to the legend, Demetrius, amused by the lively movements of a falcon which he discovered soaring over the palace gardens, caused the bird to be caught in a net, blindfolded and fettered to his throne until it became tame. Seeing the falcon dart in pursuit of a snake and swoop down on a dead hare that had been brought as a present, the king carried the bird with him on his next hunting excursion, and released it on flushing a partridge, which the falcon quickly captured.

That falconry was practised by the Persians, Turks and Arabians in very ancient times is known from well authenticated accounts. The sport appears to have been brought to Central Europe during the great migrations of the first centuries of our era. It was practised in Europe until late in the eighteenth century, after which it rapidly declined, owing to the improvement in firearms and the abolition of feudal privileges. It attained its highest development in France in the reign of Francis I. (1494-1547). It still flourishes in Persia and in the Sudan. In Asia, falcons are chiefly employed, in connection with hounds, in hunting gazelles and antelopes, while in Europe they were used in the chase of herons, cranes, ducks, pigeons, ravens, partridges, pheasants, swans, hares and rabbits. As early as the time of Charlemagne, falconry had become the favorite sport of the nobility, and the emperor ordered hunting falcons to be kept at the court of every princely vassal. Charlemagne is said to have been the first to attempt to hunt with eagles, but these fierce and dangerous birds never became popular. It is narrated that Charlemagne sent a trained eagle to the Persian king, Behram, with the information that the eagle was a better hunter than the falcon. When the eagle attacked and killed Behram's young son, the Persian monarch concluded that it had been sent with malicious intent, and sent Charlemagne a tiger, with the information that the tiger was a better hunter than the panther. The credulous Frankish monarch proceeded to train the tiger for the hunt by starving him, but the experiment was ended by the tiger devouring the emperor's brother, whose curiosity had led him too near the famished beast.

That falconry was practised extensively before the time of Charlemagne is proved by the oldest known German codes of laws, of the fifth, sixth, and seventh centuries, and by the later Saxon and Swabian codes, which prohibited the injury or theft of hunting falcons under heavy penalties. At all times, at least in Germany, falconry remained an exclusive privilege of the princes and nobles. It was a very expensive sport, the cost of which was out of all proportion to the value of the booty. The employment of falcons gradually became restricted to heron hunting, which provided the most exciting sport and the most brilliant spectacle and which was conducted with prodigal extravagance. As wild herons could not always be found, herons were bred for the sport and choice birds were bought at high prices and brought from great distances. So the idea of utility vanished completely and falconry became an expensive pastime of the wealthy nobles. The importance attracted to the sport is proved by the extensive literature to which it gave rise. A formal science of falconry was developed and even kings deigned to expound its theories at length. The German emperors Friedrich II. and Maximilian wrote treatises on the subject. Until the sixteenth century every nobleman kept his falcon, and many princes and lords carried their falcons perched on their hands, even in church. Ladies, also, indulged in the sport, and the pet falcon, like the lapdog of a subsequent period, was the constant companion of its mistress.

Not every kind of falcon is suitable for hunting. The favorite bird was the gerfalcon or Iceland falcon, the largest of the true or "noble" falcons, which, on account of its rapid and lofty flight, was so greatly preferred for heron hunting that it came to be known as the heron falcon. The female bird was preferred to the male, because of her superior size and strength. Another favorite hunting bird was the hawk, which was used especially in hunting hares, rabbits, cranes and pheasants, but also for heron hunting, and was regarded as the most eager, fearless, persevering and docile of all hunting birds. The goshawk was also a favorite, because of its spirit and courage, although it had the reputation of being short-lived. The bearded vulture, or lammergeier, was employed in hunting deer, foxes and wolves, and the sparrow-hawk in the chase of quail and larks.

The training of falcons was a difficult process, which required great patience, perseverance, sympathy and intelligence. The falconer of a great lord was an important personage, and ranked with artists. He was not allowed to have any other occupation, but was required to devote his whole time to the care of the falcons. His first task, in training a young falcon, was to win the confidence and affection of his pupil. If the bird had not been bred in captivity, but had been caught in the wild state, its eyes were covered with a hood and its claws were fettered. After a week of captivity, the hood was removed and the falcon was gradually accustomed to the sight of its keeper and the dogs, the falconer taking care to avoid looking too fixedly at the bird at first. This stage of training is illustrated in an old wood engraving, herewith reproduced. It was deemed especially important to carry the young falcon on the hand as

THE START FOR THE HUNT.

From an old copperplate.

TWO HUNTSMEN WITH FALCONS.

From an old copperplate.

STARTING FOR THE HUNT.

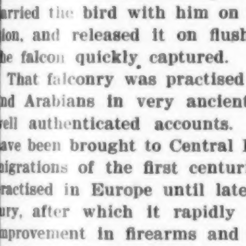
From an old manuscript.

TRAINING FALCONS.

From an old wood engraving.

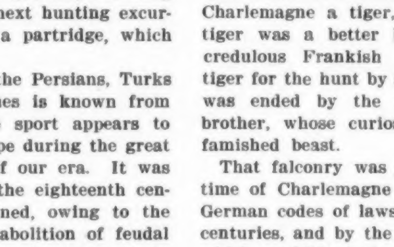
GOING HAWKING.

From the "Buechlein vom Habicht," A.D. 1497.

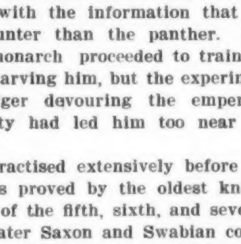


HUNTER WITH FALCON.

From a painting by Franz Floris in the Brunswick gallery.



ROBERT CHESEMAN, FALCONER TO HENRY VIII.



THE FALCONER.

From paintings by Hans Holbein the Younger in the Hague gallery.

HUNTING HERONS WITH FALCONS

From an English copperplate about 1810.

A HUNT WITH FALCONS.

From an old copperplate.

BEFORE THE HUNT.

From a painting by Philips Wouwerman in the Hague gallery.

FALCONRY IN THE MIDDLE AGES.

much as possible. In order to guide the instinct of the falcon in the desired direction, it was fed on the flesh of the species of bird which it was being trained to hunt, for every falcon was educated with reference to some particular kind of game. After the falcon's confidence had been won it was exercised in attacking its quarry in the following manner: A heron (or other bird) with its neck bandaged to prevent the falcon from inflicting a mortal blow, with its beak tipped with bits of elder cane to prevent it from wounding the falcon, and with a strong cord attached to its leg, was set down in a field about forty paces in front of the hooded falcon. When the hood was removed the falcon darted toward the heron, which either crouched and attempted to hide in the grass, or betook itself to flight, and was usually soon overtaken by the swifter falcon. In either case a combat ensued, on the ground, which was terminated by pulling the quarry away by means of the cord, while the falcon's attention was diverted by an offer of food. This maneuver was repeated many times, and the falcon was gradually taught to leave the quarry and return to his master at the call of the latter. If the falcon did not promptly obey the call it could usually be brought to obedience by coaxing and the promise (which experience appeared to make intelligible) of reward in the form of a fat pullet or pigeon. Failure of these means of persuasion indicated that the falcon was surfeited or too fat. In this case the falcon was removed by force from the quarry. If the falcon, on the other hand, showed no inclination to pursue the heron, a hunting spirit was inculcated by means of a course of fasting. The work of tuition was sometimes facilitated by associating the young falcon with an old and experienced bird, which first attacked the quarry, and substituting the young falcon for the old one after the heron had become more or less exhausted by the struggle. In this case the young falcon was allowed to kill and devour the quarry, but if it refused to attack the heron, the hunger cure was applied.

The aristocratic character of falconry was largely due to the fact that the sport was never pursued on foot. The noble lord rode to the chase, with his hooded falcon on his hand, accompanied by dogs trained to start the game. When the quarry came in sight the falcon's hood was removed and the hand which carried the bird was shaken. The falcon instantly spied the quarry, darted in pursuit and quickly overtook it. The heron often made a spirited defense, and a fierce battle in the air ensued, which usually was won by the falcon, which was stronger, though smaller, than its adversary. Occasionally, however, the highly prized falcon was transfixed by the long and sharp beak of the heron. More frequently, some of the falcons escaped during the hunt, raided neighboring poultry yards and were killed by irate peasants. A heavy penalty, however, was soon attached to the killing of a falcon, and a correspondingly high reward was paid for restoring an escaped falcon unharmed to its owner. The falcon was captured by offering it food and seizing the fetters which were attached to the legs of every hunting bird. Touching the wings or tail was prohibited.

Some falcons had a bad habit of turning aside from the quarry and settling on the limbs of trees. A bird which showed this peculiarity was taken out repeatedly on frosty and rainy days until the chilling of its feet by contact with the frost-covered branches and the soaking of its plumage with rain induced it to abandon the habit.

Falconry, like many other institutions of the "good old times," has become invested with a halo of romance, but it was in reality a cruel and bloody sport, which has very properly been abolished by the advance of civilization.—Die Gartenlaube.

ARTIFICIAL PRECIOUS STONES.*

LABORATORY MIMICS OF NATURE.

BY PROF. DR. M. BAUER OF MARBURG.

IF I have undertaken to report on the artificial production of precious stones which is now practised on such a large scale, I do not, of course, intend to refer to inferior substitutes which are so frequently palmed off for genuine stones, but only to such materials as are perfectly identical with the respective minerals in their entire constitution, chemical composition, form of crystals, and physical properties.

We are dealing here with mineral syntheses differing from ordinary attempts of this kind only by the experimenter's endeavor to give the artificial product not only its general essential characteristics but the handsome appearance required of a gem and due to transparency, luster, color, etc., and also the necessary size. It will be evident that only gems of a relatively high price can be considered in practice, since they alone will give the manufacturer an opportunity of covering the rather high cost of production by realizing a good price for the artificial stone. The list of gems which we may attempt to reproduce artificially is therefore rather restricted at the outset, and this applies with even greater force to stones in the case of which favorable results have been obtained already. At present attempts at artificial production must be limited to the turquoise and stones in the mineral group of corundum.

The first successful experiments were probably made with the turquoise, an aluminium phosphate which is opaque, crystalline, dense, water-bearing, and owes its fine blue color to a small percentage of copper. As long ago as the last quarter of the nineteenth century there appeared on the market turquoises which resembled genuine stones to such a degree as to deceive experts, yet jewelers suspected that they were imitations. No difference from indubitably genuine natural stones could be detected in their appearance, and the constitution, the specific gravity, and the microscopic structure are substantially the same. Later it was ascertained as a matter of fact that artificial turquoises were being made in Paris and Vienna in large quantities according to some method details of which have not been disclosed. It is said to be a process involving precipitation from an aqueous solution, a loose precipitate of copper-bearing aluminium hydrophosphate being obtained which is then compacted by strong pressure. It is impossible to tell this product from a genuine turquoise with certainty by the mere appearance and the usual tests, and the only material difference in behavior is said to appear when a high temperature is employed.

In more recent times much greater prominence has been reached by the artificial production of gems belonging to the group of corundum, which is aluminium oxid forming hexagonal-rhombohedric crystals. In this group is included the blue sapphire, the yellow Oriental topaz, and other stones commonly termed Oriental, and chief of all, the ruby, which in its finest specimens surpasses in value all other gems, even the diamond. In the class of transparent gems the first great success has been achieved with the artificial production of this most precious of all gems in specimens available for commercial purposes. This entire industry is now dominated by the manufacture of artificial rubies. All other syntheses of this kind which are allied to it are of so much less importance that I shall refer to them but briefly.

Gaudin, a Frenchman, was probably the first to produce artificial corundum. His procedure (begun 1837 and repeated several times) involved melting at high temperatures. The same result has been obtained since in a similar way by many other chemists and mineralogists, as H. Sainte Claire Deville, Ebelmen, Ch. Friedel, Morozewicz, etc. But in all these cases the product was of poor appearance, dull, of bad color, and often consisted only of minute crystals, many of them of microscopic size. The Goldschmidt thermit process does indeed yield large amounts of corundum, but this is entirely unavailable as a gem and is only of value for technical purposes on account of its enormous hardness.

While the production of common corundum therefore is easy, the production of the beautiful, transparent, finely-colored, precious corundum remained exceedingly difficult for a long time. Let us first consider the ruby which owes its beautiful red color to a small percentage of chromium.

The first artificial product worthy of being cut dates from the early eighties of the last century. I refer to the so-called reconstructed rubies, or Geneva rubies (rubies de Genève), it being supposed that they were made in Geneva. It is now believed to be established that they were obtained by melting together ruby fragments with the addition of partly lead-bearing fluxes. The beautiful red color of the ruby is preserved, but its hardness is somewhat diminished, and sometimes the entire mass will become amorphous and glassy, so that the double refraction and the dichroism characteristic of the ruby will disappear. Other specimens, while not entirely amorphous, show that they are not uniform crystallographically and optically. Examination with a polarizing microscope reveals the fact that some ruby fragments (although not discernible to the naked eye) have remained substantially unaltered and imbedded in a glassy body. A greater or smaller number of microscopic air bubbles are always present, but they are not detrimental. The stones have a good appearance and may be made of a pretty good size (several carats). After being an article of some importance for a while, they now seem to have vanished from the market almost entirely. They are not true artificial products in the sense spoken of above, since the raw material is genuine natural ruby. The manufacturer's aim, in this case, was simply to produce from many worthless small particles, larger pieces of apparently great value, but this could not be done without at least partial destruction of the ruby substance. The process has remained a perfect secret, but in any event it does not accomplish the actual reproduction of rubies, that is the production of a crystallized red aluminium oxid, capable of being cut, from suitable raw materials of a different character. This true synthetic reproduction of rubies shall now be discussed more fully.

The French chemist Frémy was the first who attained results of some utility, and in 1891 he published a process originally worked out by him in conjunction with A. Verneuil. This process is based on the fact that at a high temperature the action of hydrofluoric acid and water upon amorphous alumina will promote its crystallization. Pure precipitated alumina was melted at a heat of about 1,500 deg. (Centigrade) in a muffle furnace in the presence of some potassium carbonate, a small amount of BaF_2 or CaF_2 with the addition of about 2.5 per cent of $K_2Gr_2O_7$. A platinum crucible should not be used, but a clay crucible, it having been found indispensable to have the moist air and the steam-bearing combustion gases penetrate the molten mass. The amorphous Al_2O_3 was thus gradually converted entirely into a mass of Al_2O_3 crystals. It was found that in order to obtain a fine product, the employment of raw materials of absolute chemical purity was essential, particularly as regards the alumina. The size of the crucible greatly influenced the size of the crystals produced. Small crucibles yielded only small crystals, and the larger the vessel, or in other words the larger the molten mass, the larger were the rubies produced. These always had the rhombohedric crystal form of the genuine natural ruby. They were thin plates, bounded at top and bottom by the wide base surface, and at the edges by the very narrow surfaces of the main rhombohedron, and measurement showed the characteristic angles of the ruby reproduced exactly. Like the form of the crystals, the physical properties, as the specific gravity (4), the hardness (9), and the optical conditions, were absolutely identical with those of natural rubies. The product was an artificial ruby of perfect transparency and clearness and (owing to the chromium contents) of a very beautiful red color, although a few specimens exhibited the blue color of sapphire. The product therefore from its properties was eminently suitable for use as a gem, but it had one very important defect, which lay in the small size of the crystals, even the largest of them, making them unfit for practical use. The width of the thin plates seldom exceeded a few millimeters, and their thickness was always even much less, so that one could hardly think of cutting them. It was therefore attempted to set the entire pretty tiny crystals in their natural form in various articles of jewelry, and some handsome objects of adornment were obtained in this way. Notwithstanding, the artificial production according to this method never attained commercial importance, its use remained limited and soon stopped altogether. Frémy indeed expressed the hope of being able to produce crystals of practically available size by melting large masses up to 50 kilogrammes; but evidently the experiments were unsuccessful, as nothing further was heard of them. These were the so-called scientific rubies (*rubis scientifiques*).

Another article, however, has acquired considerable importance in the gem trade and now dominates this department of the market, and this is the synthetic ruby (*rubis synthetique*). In the raw state these synthetic rubies are of an appearance entirely different from that of the small crystals of scientific rubies, and judging by their appearance, raw synthetic rubies would not be suspected of being large ruby crystals of uniform structure. The process of manufacture also is materially different. This process was described by

* Translated for SCIENTIFIC AMERICAN SUPPLEMENT from a paper read before the Verein Deutscher Chemiker.

1902 by the Parisian chemist A. Verneuil, and is now employed, with greater or smaller modifications of details, for the production of very large quantities of beautiful artificial rubies and occasionally other gems of the corundum group.

The most important of the raw materials in this case also is alumina, and the coloring principle, chromium oxid. Both should be chemically pure and particularly the presence of even the slightest amount of iron should be avoided, since otherwise the product will take the little valued orange-red tinge which makes the Siam rubies so much inferior in value to Burma rubies. In order to secure uniform coloring, the mixture of chromium oxid and alumina should be perfectly homogeneous. With these requirements in view, Verneuil proceeds as follows: He makes an aqueous solution of ammonium alum and chrome alum (obtained free from iron, by repeated crystallization) in proportions corresponding to the desired shade of color, and from this solution, while hot, he precipitates chromium-oxid-bearing alumina by the action of ammonia. The precipitate is dried in the air first at ordinary temperature and then at a cherry red heat and is finally melted while in a powdered condition, in a peculiar apparatus designed for this purpose.

The apparatus consists, in its leading features, of an oxy-hydrogen blowpipe directed vertically downward, its flame being produced by illuminating gas (preferably containing a large proportion of heavy hydrocarbons) in conjunction with oxygen of the greatest possible purity. The tube through which the oxygen is supplied has at the top an enlargement in which the alumina powder to be treated is placed upon a fine-mesh platinum sieve. A little hammer, actuated electrically, strikes this sieve at short intervals, and each blow causes a cloud of the fine powder to issue downward from the sieve, the powder being then carried along by the oxygen current under pressure and thus conveyed to the flame. There the small particles are melted and are caught on the vertex of a small cone, also made of pure alumina, the so-called foot, which is disposed beneath the flame and is heated by it to incipient fusion. A few screw threads permit the cone to be raised or lowered as required and to be shifted laterally, during the operation, the progress of which may be watched through sights, the attendant using dark spectacles.

During this treatment a thin rod will at first grow upward from the foot, that is, from the tip of the incandescent alumina cone, this rod becoming thicker fairly quickly and finally developing into a round ball of greater or less regularity. The finished formation resembles a pear or rather an inverted water-bottle having a thick and wide body, the neck of such bottle adhering firmly to the foot, which must be renewed at each operation. The place of junction is thus very small, and this is of extreme importance, preliminary experiments having shown that if the solidified molten drop has a wide surface of adhesion, it will always exhibit many cracks and thereby become unsuitable for cutting. The reduction of the diameter of the molten drop at its point of contact with the foot overcame this objectionable result in the main, but still for a long time the finished drops, after solidification, would often split lengthwise into two halves with a tolerably smooth cleavage surface, each half having then to be cut separately. Later improvements enabled this defect to be avoided, and the entire drop now yields a single stone, of double size, of course, cut according to the usual methods.

In this process of manufacture the apparatus must be disposed and adjusted very carefully and particularly the gas tubes should be absolutely vertical. Furthermore, the pressure of the gas and of the oxygen must be regulated properly according to empirical data, as the treatment progresses. Apart from this, the procedure is very simple and one workman can attend at the same time to several apparatus placed in the same room. According to the more or less favorable course of the operation, which to some extent is governed by uncontrollable accidental influences, the drops vary in size somewhat. The largest drops are about 1.5 centimeters thick and 2.5 centimeters long, or several millimeters longer if we include the thin neck. The weight may be up to 50 carats (about 10 grammes) and the cut stones have a corresponding size. I have seen some as large as 12 carats.

The entire mode of production makes it clear that these molten drops, considered chemically, are nothing but pure alumina, mixed in varying proportions with some chromium oxid. If the amount of chromium oxid is slight, the color will be light pink. Stones of this character have been termed erroneously synthetic topazes on account of their striking resemblance to the so-called pink topazes which are obtained by heating yellow Brazilian topazes. Genuine synthetic topazes, however, have not yet been produced. If the amount of chromium oxid is increased, say up to 2 per cent or a little more, beautiful dark red stones of various tints will result, among them fairly often the rare and highly valued pigeon blood red of the natural Burmese rubies, the pure carmine red. It seems that these different shades of red still depend, in the main, upon accidental causes, so that at present they cannot yet be produced at will. If the chromium oxid is omitted altogether, quite colorless drops are obtained which correspond to the white sapphire. Whatever the color, the mass is perfectly clear and transparent, except at the bottle's neck and its bottom; that is, the part formed last during the process, where the drop always terminates with a thin cloudy white or grayish layer. With the polarization microscope we can observe that each drop represents a complete unitary crystal whose crystallographic principal axis and optical axis frequently, but not always, extend lengthwise in the direction of the bottle's neck. It is true these crystals are generally rounded off externally, so that their true nature cannot be perceived at once with the naked eye. In rare cases, however, the bottle-shaped body exhibits six fairly regular plane surfaces parallel with the direction of the axis, which intersect in six similarly regular edges under angles of 120 deg., corresponding to a hexagonal prism and to the natural characteristics of a ruby. Minute ruby crystals are frequently found in large numbers on the bottle neck and on the small alumina cone or foot. As with the scientific rubies, all other properties are like those of natural rubies, such as specific gravity, hardness, coefficients of refraction, dichroism, etc. In brief, here again we have an artificial ruby which is absolutely identical with the natural ruby in every respect, chemically, crystallographically, and physically. As it also possesses the size, clear transparency, and magnificent color required of a precious stone suitable for jewelry, it may be said that with these synthetic rubies the problem of artificially producing this valuable gem has been thoroughly solved, in the main. The methods of production may perhaps be further improved, but the product itself is hardly susceptible of greater perfection.

This is therefore the process of manufacture which has acquired such importance since 1902. A. Verneuil, who is using it upon a large scale in Boulogne, near Paris, states in one of his publications that during the last six or seven years he and others have made there annually more than five million carats (1,000 kilogrammes) of these artificial rubies. In Germany the "Deutsche Edelsteingesellschaft Zu Idar," according to its circular, is carrying on the same manufacture, employ'_ a special process worked out by Prof. A. Miethe of Charlottenburg, details of which are not available.

The question will be asked if it is possible to distinguish these artificial rubies with certainty from natural ones. At first this was comparatively easy. The synthetic stones produced first, when viewed under the microscope, showed numerous round air-bubbles which it is true did not impair their fine appearance. But these bubbles are entirely lacking in natural rubies, which on the other hand sometimes contain small angular cavities, so-called negative crystals, and also minute real crystals. Among these there are especially noteworthy microscopic brown needles which are often found ingrown in the crystals parallel with the base in three directions intersecting under angles of 60 deg. Improvements made in the manufacturing process have led to the almost entire disappearance of the small round bubbles, but the tiny needles, etc., characteristic of natural rubies cannot be embodied in the artificial ones, so that the presence of such needles, etc., indicates a natural ruby with certainty. If they and the round bubbles are both absent, then no microscopic test of genuineness will be available.

In regard to telling the difference by the mere appearance, without the help of instruments, it should be noted that experienced gem connoisseurs assert they can always recognize an artificial ruby as such and distinguish it from a similar natural ruby. They say that even with the finest color and the most perfect qualities producible artificially the synthetic stone still always lacks the beautiful velvety gloss of the natural product. Be that as it may, it certainly requires a very large experience, and I must confess that I have not reached this point as yet. I have seen a great many artificial and natural rubies, both separately and side by side, but I have not always been able to distinguish them with certainty.

It will therefore be readily understood that this manufacture has caused considerable anxiety in the ruby trade, all the more in view of the fact that the price of even the best synthetic stones, which at present amounts to about 75 cents per carat (0.205 gramme) is far below that of corresponding natural rubies. A one-carat natural ruby of the finest quality may cost more than $250, a two-carat stone up to $2,500, and still larger ones, on account of their scarcity, are sold at often incredible fancy prices. On the other hand, synthetic stones of 10 carats and over, which size natural stones have attained in only a few instances, can be produced artificially with great ease.

It is not surprising, therefore, that the owners of natural rubies should have devised steps to guard against the seriously threatened depreciation of their dearly-acquired possessions. Thus, among others, the syndicate of Parisian dealers in precious stones resolved that the name "ruby" should be applied only to stones cut from natural raw material and that every jeweler should be obliged to expressly declare artificial stones sold by him and to unconditionally take back any artificial stone brought into the market by him unwittingly. It is of course very doubtful if the sale of artificial rubies can be effectively checked by such measures for any length of time, since the recognition and distinguishing certainly are very difficult, to say the least, and of course entirely impossible in the case of the general public. No doubt very many synthetic rubies have been brought upon the market without declaration, with and without the seller's knowledge, and have been accepted as natural by the public. The surprising fact has also been ascertained that the manufacture of artificial rubies has not caused a fall in the price of natural rubies; on the contrary, it has gone up somewhat since that time. The fears of the owners of natural rubies are therefore unfounded, at least for the present.

Besides rubies, artificial stones of other colors, all belonging to the variegated group of precious corundum, have been made according to Verneuil's process and placed on the market, but the coloring agent is not generally known in most cases. Compared with rubies, this is of some scientific but of no economic importance. The natural stones of this kind have only an inferior place in the precious stone trade, and their price is not so very high, so that their reproduction is not remunerative in the same degree as with rubies.

We have spoken already of the colorless corundum, the white sapphire. It can be produced in very beautiful specimens, just as clear as water, which have exactly the same properties as natural stones, but are said not to equal them in luster and fire.

A very beautiful stone is the artificial yellow corundum, which corresponds to the natural Oriental topaz or topaz-sapphire; the violet Oriental amethyst, the violet ruby, has also been reproduced artificially.

We shall deal a little more fully with the artificial production of the blue sapphire, which after the ruby is the most important gem of the corundum family. In this case particular difficulties have been experienced in the application of Verneuil's method, and real success has not been achieved so far. What is now sometimes called "synthetic sapphire" is not, as in the case of the ruby, an artificial stone having all the properties of the natural one, but a product which differs from the natural article materially in important points.

The blue coloring agent of the natural sapphire is not proof against the action of heat (like that of the ruby) but is destroyed thereby and for this reason is thought by many to be of organic nature. Accordingly, in making artificial sapphires, cobalt in the form of Co_2O_3 has been resorted to as a means of giving a blue color to the molten alumina mass. But, quite unexpectedly, the molten drop at first absolutely refused to take any color. Even when an addition of 5 per cent of Co_2O_3 was employed, none of it became incorporated, and the drop remained colorless. The coloring matter did not enter into the melt until a further addition of a few per cent of CaO or MgO was made to the mass, and then even 0.1 per cent of Co_2O_3 was sufficient to produce a very bright blue color. In this case, however, these slight admixtures of foreign substances produce the remarkable result that the molten drops consisting chiefly of Al_2O_3 do not form a unitary crystal after solidification (as they did in the case of the ruby, etc.), but they yield a glassy amorphous body having indeed the same external shape as in the case of the ruby, but no double refraction and no dichroism, and a smaller hardness than crystallized alumina and also a smaller specific gravity (from 3.6 to 3.8 instead of 4). Physically considered, it is therefore a substance totally different from corundum and comparable to quartz glass (fused quartz in its relation to rock crystals). In any event, we cannot term this a synthetic sapphire in the sense defined at the beginning of this paper. The small contents of CaO, MgO, and of the cobalt compound have evidently been sufficient to entirely destroy the crystal-forming capacity of the molten alumina, whereas in the case of the ruby the coloring chromium compound is presumably admixed as Gr_2O_3 isomorphous with alumina and therefore does not hinder crystallization.

Even in external appearance this artificial product is far inferior to the beautifully blue natural sapphire. It is too strongly blue, of a hue no genuine sapphire will exhibit; it is the vulgar blue color of cobalt glass, smalt, and we miss the attractive velvety gloss of the natural crystallized stones. Furthermore, by lamplight the color turns to purple, which defect may indeed be avoided by a slight addition of iron. The conclusion is that a real synthetic sapphire does not exist as yet and for the reason stated above, is not likely to be produced in the near future, at least not according to Verneuil's method.

There is, again, the so-called synthetic alexandrite. The genuine alexandrite is the dark emerald-green

variety of the mineral chrysoberyl, another variety of which, known as cat's eye, also has some importance among gems, being distinguished by a peculiar wavy reflection of light. The alexandrite is noted for its remarkable change of color. In daylight only it will show an emerald-green, by lamplight it has a decided purple color. Among the molten drops produced in accordance with Verneuil's method and the stones cut therefrom, there are some that exhibit a similar change of colors. In daylight they appear light green, under artificial light beautifully purple. For this reason they have been considered artificial alexandrite, or at least designated as such. Careful analysis has shown, however, that these artificial stones contain no beryllium, or at least very little of it, that they have not the specific gravity of alexandrite (3.7), but that of corundum (4), and likewise that all other properties, practically the optical ones, are those of corundum and not of alexandrite. We are therefore dealing not with alexandrite but with an artificial corundum, and as a matter of fact there are in this group, but only as specimens of extreme rarity, some natural stones in which we observe a change of color similar to that seen in these artificial gems. How the latter are made, that is, what coloring principle is used, is entirely unknown.

If we sum up the substance of the facts recited above, we perceive that, if we except the so-called synthetic sapphire, Verneuil's method is applicable at present only for producing gems of the corundum group as crystallized bottle-shaped molten drops. The topaz and alexandrite cannot as yet be reproduced in this manner, notwithstanding the suggestive names given to some of these artificial products.

In connection with the above remarks, I may refer to the so-called synthetic emerald. The emerald is the fine green variety of the mineral beryl, and in flawless specimens is about equal in value to the ruby in the list of precious stones. What is called synthetic emerald and brought into the market as such, is nothing but fraud. Sometimes it is glass colored green with chromium, sometimes so-called doublets. The top of the cut stones and the bottom are colorless glass or rock crystal or aquamarine, a variety of beryl of a light bluish-green color and of no great value on account of its frequent occurrence. Between the top and bottom there is inserted a thin emerald-green plate of glass or of gelatine, which when the stone is viewed from above, gives it the same color in a perfectly deceiving fashion. But if the stone is looked at from the side or otherwise examined closely, the imitation will be discovered readily; such examination, however, cannot be made when the stones are set. Other similar combinations of worthless green and colorless parts have also been observed. The manufacture of these imitations is also said to have its chief home in Paris. The synthetic production of real emeralds has not been accomplished as yet, neither has that of aquamarines or other varieties of the mineral beryl.

In conclusion, I shall mention the diamond, but only to say that it has been produced in various ways in the form of very tiny crystals. Such manufacture, however, has not so far acquired any importance for the trade in precious stones; I therefore believe that I should not enter into the matter any further at this place.

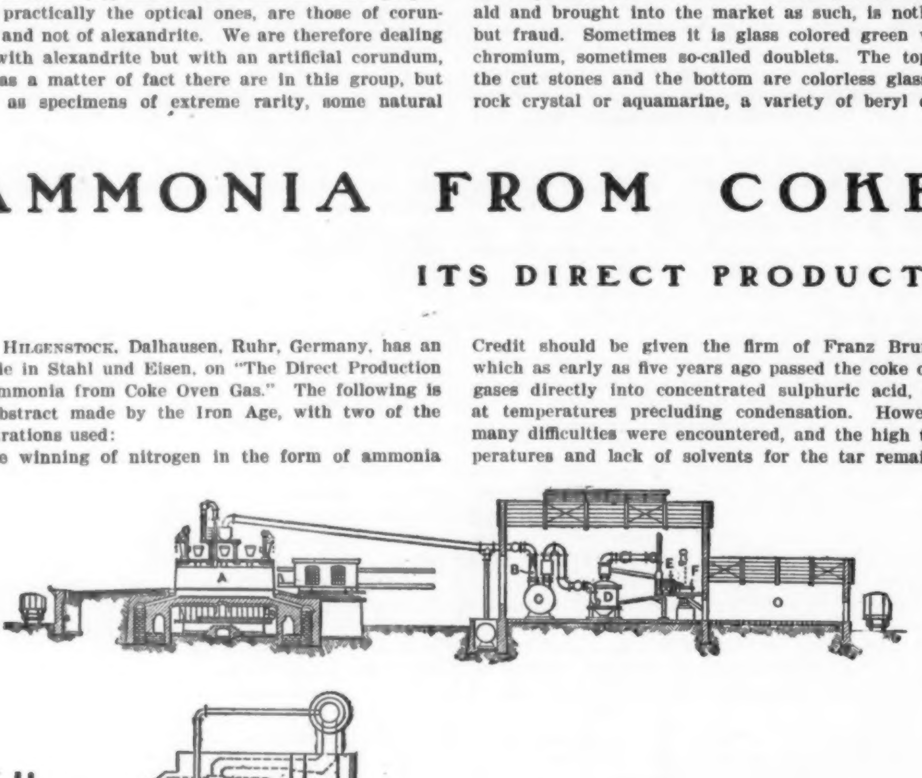
AMMONIA FROM COKE OVEN GAS.

ITS DIRECT PRODUCTION.

G. HILGENSTOCK, Dalhausen, Ruhr, Germany, has an article in Stahl und Eisen, on "The Direct Production of Ammonia from Coke Oven Gas." The following is an abstract made by the Iron Age, with two of the illustrations used:

The winning of nitrogen in the form of ammonia from coke oven gases was concomitant with the preparation of phosphorus in useful form for agricultural purposes. The method laid down by Dr. Otto in 1884, while improved and simplified, still depends upon five distinct stages: First, the cooling of the gases by the air and water circulation; next, washing the gases with cold water to remove the last traces of tar and ammonia; then separation of tar and ammonia water in large tanks, through their specific gravities; then the driving off of the ammonia by steam and added lime; finally, the condensation of the ammonia into a strong solution or else combination with an acid, making a salt.

This roundabout method has been and is used because we have not developed a shorter one. It would seem possible to take the ammonia vapor as it comes from the ovens, diluted only by gas, into an apparatus, and there complete the operation. This supposition was based upon the working of the steam jet, and the knowledge that tar itself is the best solvent for tarry vapor. Experiments along these lines gave surprising results when the precaution was taken not to let the tar exceed 175 deg. F., and that no condensation took place. The tar for washing was introduced by a steam jet, and at the works where these trials were made it was perfected to a point where less than 45 grains remained in every 1,000 cubic feet of gas. Credit should be given the firm of Franz Brunck, which as early as five years ago passed the coke oven gases directly into concentrated sulphuric acid, this at temperatures precluding condensation. However, many difficulties were encountered, and the high temperatures and lack of solvents for the tar remained a detriment to the process for a long time. Other methods involving several stages could have been applied, but the one described herewith has given perfect satisfaction. Experiments have shown that the very small quantities of condensation products which separate out with the tar contain practically only ammonia salts, and these are returned to the gases in the saturation chamber with the steam. Where there are occasional abnormal quantities of condensation products, as for instance with very wet coal for coking, provision is made to separate these gases from the drier ones.



FIGS. 1 AND 2.—PLAN AND ELEVATION OF AN INSTALLATION FOR THE DIRECT PRODUCTION OF AMMONIA FROM COKE OVEN GAS.

The first installation using the "direct method" for ammonia is in operation at the Julia Colliery of the Harpener Association. Here the usual troubles of a newly introduced process were met with and overcome. Even here from the very first a perfectly white sulphate of ammonia was obtained. It had over 25 per cent. ammonia and only a few tenths free acid. The next installation was at the Vondern Colliery, where everything has worked smoothly from the start, the salt after centrifuging being perfectly white and containing 25.26 per cent. ammonia, and 0.20 per cent. free acid. After a short storage it becomes perfectly odorless.

The accompanying illustrations give a plan and elevation of a "direct" method installation. *A* shows the coke ovens. In the tar jets *B* a very intimate mixture of the tar and gases takes place, so that when the tar catch basins *C* are reached the gas is free from the tar. The tar pumps *J* supply the jets continuously and the product caught in *C* is carried into storage tanks. The hot gases, after the tar separation, and containing all the water vapors and ammonia, are led into the absorption tanks *D*, which are closed, and in which there is the necessary sulphuric acid. The reaction between ammonia and acid is sufficient to keep the temperature up to a point giving proper results, the sulphate of ammonia drops to the bottom after sufficient saturation, and is carried upon the drainage platform *E* by means of an ejector in the usual way. The centrifugal machines *F* dry it, and it is then carried to the storage *O*. The mother liquor from the draining platform is returned directly to the absorption tanks.

The gas is now dried, passing through the condensers *G*, fed by pumps *K* in the usual way. The gases pass to the benzol extraction apparatus and thence to the coke ovens for firing, or else into gas tanks for city lighting. At *M* is the acid tank and at *N* the tar shipping tank.

The advantages of the "direct" process are obvious. The washing and distilling apparatus is done away with, steam is saved, settling ponds and removal of slimes are no longer necessary and the operation is simple and cheap.

Warm-blooded animals possess fundamental means of protection against foreign substances which have invaded the organism. To the entrance or formation within the body of bacterial or other poisons, the organism responds by the production of specific antidotes or antitoxins, while it reacts to the invasion of living bacteria by producing special solvents or lysins. These natural safeguards, which are collectively called alexins, are at the disposal of warm-blooded animals in a normal state of health, and upon their presence depends the germicidal power which the cells of the body normally exhibit. The leucocytes or white corpuscles of the blood are concerned in the production of these antidotes. The well-known fact that fresh-water crabs possess very little power of resistance to the attacks of bacteria, so that an infectious disease almost annihilated the crabs of Europe in a short time, suggests the question whether cold-blooded animals possess these natural means of protection. Investigations made by Angerer at the Biological Experiment Station of Munich have shown that the blood of fishes (carp) exhibits a powerful germicidal action upon typhoid bacilli and other bacteria, which are devoured and digested in great quantities by the white blood corpuscles, by the process which Metchnikoff calls phagocytosis. Many experiments on crabs have confirmed the prevailing assumption that the blood of these crustaceans possesses only a very small power of producing bactericidal substances. The blood of snails and mussels is also very nearly destitute of bactericidal power, while on the other hand the slimy mucus exuded by hibernating snails possesses a strong germicidal power. The May beetle, also, appears to be very well protected by nature. This contrast between fishes and snails, crabs and May beetles proves that the thickness of the external armor stands in no relation to the power of the organism to protect itself against bacteria, and also that the armor does not prevent the entrance of bacteria.

VARIOUS TYPES OF SAFETY LAMPS.*

A CONSIDERATION OF THEIR COMPARATIVE SAFETY.

BY J. B. MARSAUT.

SINCE Davy, nearly a century ago, constructed the first safety lamp, almost innumerable inventors have produced lamps bearing their names, but in a majority of instances the alleged improvements have been more apparent than real. At various times commissions have been appointed, and are still maintained by several of the European governments, to pass upon the safeness of safety lamps, one of the earliest being the one headed by Le Chatelier, in 1889. After pointing out a few general conditions, I shall outline the progress in the development of those lamps that were approved by Le Chatelier, and then describe a few of those that have appeared since that time and have been tested with satisfactory results.

PRINCIPLES OF THE SAFETY LAMP.

It has long been known that the Davy and all other lamps in which the flame is protected by one or even two gauzes, without an outer mantle, are not safe in a current of inflammable atmosphere blowing with a velocity of 2 to 4 meters per second; in such a current, combustion of gas will begin inside the lamp, will heat the gauze to redness and will then transmit the combustion outward to the surrounding atmosphere. This knowledge has been gained both by experiment and by the sacrifice of innumerable lives. If, likewise, a lamp of this simple type should become filled with an explosive mixture, the detonation that would ensue inside the lamp would often suffice to blow the flame outward and cause an explosion. This phenomenon is the more likely to occur if the interior volume of the lamp is large in proportion to the area of the surrounding gauze. A relatively large gauze is therefore conducive to safety.

My experiments have pointed to a number of other interesting details. For example, in a lamp having a glass cylinder surmounted by a gauze mantle, an interior explosion is the more violent as the flame of the lamp is the smaller. This is because the amount of inert gas present in the lamp, as a product of wick combustion, is small. Thus a large flame increases the safeness of a lamp of this type, contrary to the common opinion. Fortunately, it is not easy to fill a lighted lamp with a perfectly proportioned explosive mixture of gas and air, but such a contingency is within the realms of possibility.

Working in a testing laboratory with artificial air and gas mixtures, and exploding them at will by an electric spark, the following phenomena are readily observed: (*a*) In the Clanny, Marsaut and other lamps having a glass cylinder surmounted by a wire gauze, an explosion is the more violent as the point of ignition approaches the bottom of the glass. The height of the glass should thus be as little as is consistent with satisfactory illuminations. (*b*) With mixtures of illuminating gas and air, transmissions of combustion through even two gauze mantles are common; three concentric gauzes, however, seem to suffice to restrain such transmission. (*c*) The frequency of transmission of flame through the gauze of a safety lamp of the type described above, is still more apparent if the diameter of the gauze mantle is less than that of the glass cylinder, or if the space within the gauze is obstructed.

Although natural firedamp is much less dangerous than carefully adjusted mixtures of air and illuminating gas, such as are used in a laboratory, the fact remains that the results attained by experiment should be borne in mind while designing safety lamps; that is, the height of the glass cylinder should be reduced to the lowest limit, the interior should have a cylindrical or very slightly conical shape, and all obstructions to the quiet circulation of currents within the lamp should be avoided.

Among the large number of safety lamps extant in 1889, there were really only a few distinct types, and of these LeChatelier recognized only six, the Davy, Clanny, Mueseler, Marsaut, Fumat and Gray lamps, besides the electric light, which at that time was still in the experimental stage.

DAVY AND CLANNY LAMPS.

Both of these lamps, in which the wire gauzes are not protected by any kind of exterior mantle, have long since outlived their usefulness, as affording only a slight degree of safety. The inventor of the Clanny lamp, by inserting a glass cylinder at the base of the gauze, increased the illuminating power of the flame, and at the same time, though he was possibly unaware of it, introduced another marked improvement, the downward draft, whereby a gaseous atmosphere would generally extinguish the flame and thus serve as a warning. The gas might, however, continue to burn inside the gauze, when the Clanny would then have all the dangerous features of the Davy lamp. Lamps of these two types have long been interdicted in France and Belgium, though, under the name of Wolf, they are in almost exclusive use in Germany.

MUESELER.

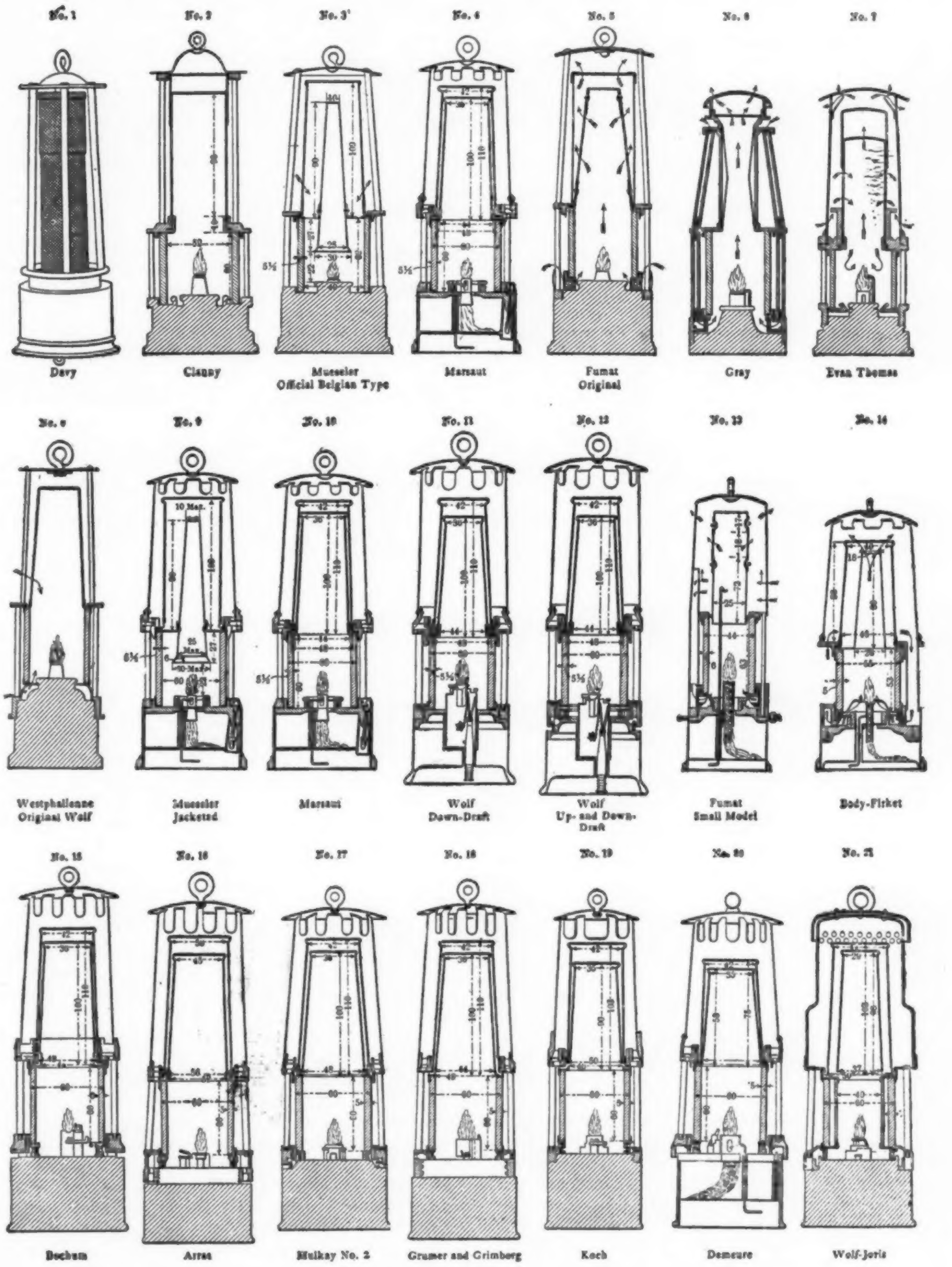
The Mueseler was like the Clanny lamp with the addition of an interior chimney supported by a metallic diaphragm at the level of the top of the glass cylinder. These parts were expected, by reason of their remaining filled with inert gas, to prevent combustion of inflammable gas inside the gauze; accession of firedamp would cause a small explosion in the base of the lamp whereby both the lamp's flame and the burning gas would be extinguished. It was found, however, that a turbulent current of inflammable gas might sometimes upset the natural draft of the lamp, filling the chimney with an explosive mixture which then acted as a fuse to conduct the combustion to and through the gauze. An excess of gas, also, by incomplete combustion within the lamp, might yield an amount of carbon monoxide capable of transmitting the flame to the exterior.

In an atmosphere of illuminating gas it has been found quite possible for the interior combustion to pass through the diaphragm and even to the outside. In spite of these deficiencies, the use of the Mueseler lamp remained obligatory in Belgium until the tests of Watteyne and Stassart at Frameries in 1905 proved its inferiority. The construction of the Mueseler lamp, especially as to the thoughtfully designed dimensions of the glass cylinder and the method of mounting this in copper rings, is highly to be commended.

MARSAUT.

The Marsaut lamp borrows the dimensions, the oil reservoir, the thick glass and the method of mounting found in the Mueseler lamp, but instead of the interior chimney and diaphragm has a smaller gauze inside the outer one and a metallic jacket or mantle outside of both. The double mantle permits the rapid escape of the products of an interior combustion of gas, while the jacket protects the lamp from drafts of explosive atmosphere and from breakage. When tested in an atmosphere of illuminating gas and air, three gauzes are found to be necessary to insure the isolation of an interior gas combustion, but in the ordinary atmosphere of a gaseous mine two gauzes have been proved, beyond question, to be adequate.

English tests of the Marsaut lamp with two gauzes and a jacket, by maintaining a gaseous current of 20 meters per second velocity directed continuously against the lamp, have succeeded in causing a transmission of combustion outwardly, but in these tests the lamp was transformed into a miniature furnace which melted the gauze, a condition which would never be realized in a mine. In these same tests,



LEADING TYPES OF SAFETY LAMPS.

* Abstracted from the Bulletin de la Société de l'Industrie Minerale, March, 1909.

however, a lamp with three gauzes proved entirely safe. The Belgian commissioners in their report, in which they condemn the use of the Mueseler lamp in distinctly gaseous mines, make the following statement as to the Marsaut: The Marsaut lamp with vegetable oil withstood all tests, both with and without dust, both new and old lamps being tested; the Marsaut lamp with benzene, although it became heated, withstood all tests for the passage of combustion through the gauze.

FUMAT AND GRAY LAMPS.

The Fumat lamp was designed to obviate the possibility of explosions within the lamp, by causing an inflammable gas to burn as rapidly as it enters. This was accomplished by reducing the diameter of the glass cylinder. A solid metal cylinder covered by a gauze cap was put outside the usual wire gauze. Upward draft was provided in order to improve the illuminating power. This lamp did not prove satisfactory, and was superseded in 1903 by a smaller model, in which the current of air is introduced into the lamp through a small metallic duct leading from near the top of the lamp down to the vicinity of the flame. This accomplished about the same result as the Gray lamp, but without interfering so much with the illuminating power, since the large tubes through which the air is conducted into the Gray lamp cast rather large shadows. Neither of these two lamps has come into general use.

THE WOLF LAMP.

The Wolf is the most common of the lamps that have come into use since the time of LeChatelier's investigations. It has acquired its present form by gradual improvements. The first step was to substitute gasoline for heavy oil in the ordinary Westphalian lamp. This came into quick favor in Germany, but the backwardness of French miners to accept gasoline for the illuminant compelled other improvements. The Wolf lamp first took on two gauzes, then a metal jacket, becoming, though not appreciated by Wolf, the same thing as the Marsaut lamp. A further change was introduced by causing the air to enter both from above and below the glass.

As with all lamps drawing their air from below, an inflammable gas will burn inside the Wolf lamp, heating the oil reservoir sometimes to the danger point, and frequently cracking the glass. The illuminating power of the Wolf lamp is certainly better than that of some other lamps, but it is well known that the security of a safety lamp is inversely proportional to its candle power. It seems to me that the points of the Wolf lamp to which credit is chiefly due are the use of gasoline instead of heavy oil and the admirable relighting and locking appliances which were designed to go with the lamp.

BODY-FIRKET.

Among the lamps approved by the Frameries investigators is the Body-Firket. This resembles the Fumat in respect to the admission of air while its interior arrangement is like that of the Gray lamp. It has the Upton and Roberts shield for protecting the glass from the flame of an internal combustion of gas, which is a very valuable adjunct to any lamp deriving its air from below. The lamp has only one gauze and one jacket, while the interior cylinder affords all the disadvantages referred to above in discussing the Mueseler lamp. Its illuminating power is also deficient.

RECENT LAMPS.

As a result of the long investigation at Frameries, the following lamps were permitted in Belgian mines under regulation as to their shape and size: Mueseler (jacketed); Marsaut; Wolf (with either up or down draft); Fumat (heavy oil only); Body-Firket (heavy oil only). The Frameries commission put no restraint on the invention of new lamps, and as a result at least seven new lamps have been authorized since 1904. They are the Bochum, Arras, Mulkay No. 2, Grümer & Grimberg, Koch, Kemeure, and the Wolf No. 3. An examination of the first six of these lamps shows them to be only slightly modified types of the Wolf pattern, differing among themselves only in the method of baffling the entrance of air. Some of them have less illuminating power than the Wolf lamp, and it is hard to see any reason for their existence. The Wolf No. 3 lamp, invented by H. Joris, is smaller and lighter than many others. It has a double glass cylinder, being to this extent more complicated than its prototype. Double glasses have been tried before, but without affording any marked advantage.

GASOLINE VS. HEAVY OILS.

Gasoline has now for a long time been permitted in German mines as an illuminant, and its use is coming more and more into favor in France and Belgium. It has the advantage of yielding a brighter light, but many engineers are still uneasy as to its safety. The defects of gasoline for this purpose are more or less grave. Lamps burning benzene get hot quicker than those burning oil, especially in a gaseous atmosphere, and the glass cylinders break more frequently. To obviate these difficulties, the lamps have to be made more bulky and heavier, while at the same time the thickness of the glass has to be diminished, so that if one should take hold of a hot lamp by mistake, and drop it, there would be danger of breaking the glass and causing an explosion.

In certain kinds of work in which a lamp is subjected to a good deal of jolting, a gasoline lamp goes out more frequently than an oil lamp, and the handling of gasoline requires greater caution than that of oil. It is possible to get better illumination out of an oil lamp by enlarging the gauze mantle and making the lamp bigger, but this has corresponding drawbacks. The argument that lamps of high illuminating power decrease the danger of falls from the roof, by enabling the workmen to discover sooner the symptoms of caving ground, seems to me to be not well demonstrated, which opinion is shared by the eminent engineer Harzé, the Belgian director general of mines.

AIR DRAFT AND RELIGHTING.

From the preceding descriptions it will have been noticed that in some lamps the air is admitted from above the flame, in others from below, and in others from both directions. Each method has its own effect on the illuminating power of the lamp, but they are not all equally safe. The object of the downward draft is to keep the lamp filled more or less with a volume of inert gas, to the exclusion of any possible explosive mixture; only in exceptional circumstances can a perfectly explosive mixture make its way into such a lamp. With an upward or a mixed draft, on the other hand, the lamp, sometimes highly heated in a gaseous atmosphere, acts as a chimney in drawing inflammable gas upward into the chamber; if the light should go out, the gaseous mixture would still circulate, expelling the inert products, and might end in the accumulation of a perfectly explosive mixture within the lamp.

If, now a relighter should be put into operation an internal explosion would ensue which would probably be conducted to the exterior. The rules of France and Belgium forbid the relighting of a lamp that has been extinguished by a fall, a blow or any accident that might cause a rent in the gauze; German regulations prohibit the relighting of a lamp at any place in which an accumulation of gas is suspected, but if a lamp is provided with a relighter, such rules as these are of little effect. In my opinion it would be wise to forbid the use of a relighter in any lamp not having downward draft alone. A downward-draft lamp is thought to be somewhat less easy to relight than one with an upward draft, but German experience does not support this idea.

LOCKING OF LAMPS.

The locking device is not an essential feature of the safety lamp, but it assists greatly in assuring the safety for which the lamps have been designed. Many inventors have attacked the problem, and it may now be considered as satisfactorily solved. We have a choice of several different but equally effective methods, some of which are very ingenious, as Cuvelier's hydraulic lock, the magnetic lock originated by Villiers and improved by Wolf, and the lead-rivet lock.

Personally I prefer a lock consisting of a large lead rivet which shall be easily felt and visible to the naked eye. A group of miners supplied with lamps h-- this kind of a lock, if barricaded behind a fall of roof, could make their joint supply of oil last a great while.

THE OLDEST NEWSPAPERS.

During the Roman empire the publication of newspapers had already attained a certain vogue, and if a few numbers of the official daily record which Cæsar prepared with the assistance of many thousand writers and distributed over the whole cultivated world of his time had been preserved for us, we would be much better instructed to-day in regard to the daily life of those days. The Acta Diurna Publica gave reports of the splendid public festivals, of the military campaigns and victories, of social and literary events, and of piquant adventures. The oldest of all the newspapers that still exist to-day, the first printed newspaper of the world, is the Chinese publication, the King Pao, that is, the Chronicle of the Capital. It is said to have been founded in the year 911 of the Christian era, but appeared regularly only in and after 1351. For four centuries it was published every two weeks, and since 1800 every day. To-day it is published three times a day, and its three editions are printed on different paper, the morning edition on yellow, the noon edition on white, and the evening edition on gray paper, to avoid all confusion.

The origin of the first European newspaper is still in a mist of uncertainty. In obedience to circumstance, certain coteries and societies were formed as centers for which much important information was acquired and then distributed in directions suited to a specific purpose. Thus in Germany the Fugger trade office in Augsburg, which in its writing rooms gathered all kinds of important news, and for a yearly assessment distributed them to all those who had a definite desire for them. Besides these Fugger-written "newspapers" so called, "versatile" men composed newspaper letters. The Emperor Rudolph II., for instance, paid two hundred florins in gold every year to a man in Cologne who wrote him regularly a chronicle of the events in France and the Netherlands. Out of these written newspaper letters were then developed the printed newspaper in the years of the narrow interval that immediately preceded the seventeenth century. The Austrian Michael von Aitzing must be regarded as the founder of the modern German newspaper method. In 1583 he sold at the Frankfort fair a quarto edition of the Cologne Transactions, relating negotiations which had been conducted between the Pope and the Elector Gebhard. As this periodical always appeared during the Frankfort fair, it was also called the News of the Fair, acquired great popularity, and soon was confronted with various competitors. This News must have been followed soon by the German real newspaper, of which the earliest volumes cannot be shown, and the only early volumes extant or accessible are a volume of the newspaper published in Strasburg in 1609 and a volume of a newspaper published in Augsburg in the same year. The title of the Strasburg newspaper, ample, and crudely, sometimes grotesquely, spelled after the manner of that day, was:

"Relation of all that may occur and all the noteworthy news that may be heard now and then in Upper and Lower Germany, also in France, Italy, Scotland and England, Spain, Hungary, Poland, Transylvania, Wallachia, Moldavia, Turkey, and so forth, in this 1609 year, all of which I will put in print in the most faithful manner, just as I receive it."

The oldest English newspaper first appeared in the year 1622, while the reports of the English Mercury, attributed to the year 1588, are now known as forgeries. The first French newspaper was founded by Théophraste Renaudot, a physician, and it was he who projected the first labor bureau. The title of the newspaper was La Gazette, and was so called after the small Venetian coin which was the price of the written newspapers that had been bought formerly on the Rialto. This paper appeared for the first time on the 30th of May, 1631, and its whole extent was four pages. Since 1762 it has been called La Gazette de France, and is published at the present day.

The correctness of the assertion that La Gazette de France is the oldest French newspaper is contested in a recent issue of the Boersenblatt fuer den Deutschen Buchhandel, a bulletin published by the German book trade, with the following statement: "The founder of La Gazette de France, Théophraste Renaudot, had already a long time previously begun the publication of Les Petites Affiches, which is still published to-day and is now a mere advertising medium. The original purpose of this paper was the publication not only of advertisements, but of opinions and news regarding private individuals who themselves had an interest in the dissemination of them."

But even Les Petites Affiches was not the oldest French newspaper really. The merit of having published the oldest one is due to Charles VIII. When he, in August, 1494, led his army into Venice, and in the following year conquered the kingdom of Naples, he published a regular periodical report of the progress of his campaign which was essentially a newspaper.

In regard to the afore-mentioned La Gazette de France, its original title was the simple name Gazette. Théophraste Renaudot introduced this name from Venice. One stage of a journey he had made was the city of the Doges. While in this city he caught sight of the oldest Venetian newspaper, a public print that contained reports of municipal affairs and general news and was sold for a gazetta, an old Venetian coin having, say a value of two cents. And the name of the coin was the title of the paper. Renaudot promptly conceived the idea of giving to his own paper the same title. La Gazette de France was sold in the streets, and was greeted with a most satisfactory demand. Certainly it was Renaudot who provoked the first phase of the marvelous vogue with which the French newspapers have been rewarded—Renaudot the first French journalist.

The Gazette had celebrated collaborators, indeed. A few of them, for instance, were Louis XIII., Cardinal Richelieu, and his wily assistant, the Capuchin monk François Leclerc du Tremblay. The editorial staff consisted of Renaudot and his sons Isaac and Eusebius. Later Renaudot was the representative in the Gazette of the policies of Mazarin, the successor of Richelieu.

It should be stated that the first real daily newspaper published in France was the Journal de Paris, which was founded in 1777.

Synderamine Paint.—Grind 10 parts of finely pounded graphite, 10 parts chalk, 30 parts of heavy spar, and 15 parts of well-dryed linseed-oil varnish to a paint of the consistency of ointment. Before use the paint should be diluted with a suitable quantity of linseed-oil varnish.

ASTRONOMY AND ASTROLOGY.

THE DEVELOPMENT OF ASTROLOGY.

BY F. W. HENKEL, B.A., F.R.A.S.

FROM the earliest times down to the last two centuries no very clear distinction was made between astronomy and astrology. The former was often designated "natural" astrology, dealing with the movements and appearances of the heavenly bodies; the latter was called "judicial" astrology, and dealt with rules for determining their supposed influences upon terrestrial affairs, the destinies of individuals, especially of those "highly placed" in office. There seems little reason to doubt that it was a desire to know the nature of this supposed influence, especially as affecting themselves personally, that led to the patronage of the science by rulers. Astrologers were attached to the courts of the principal princes of Europe during the Middle Ages, and such astronomical work as they were allowed to perform was often undertaken with this end in view. "Astronomy would starve," exclaimed Kepler on one occasion, "were it not for her harum-scarum daughter Astrology." He himself, the illustrious discoverer of the three great laws of planetary motion, "Imperial Astronomer and Mathematician" to the Emperor Rudolph, was obliged to eke out his irregularly paid stipend by the money he earned from casting horoscopes and "fortune telling by the stars." Lord Bacon sometimes, though with little justice, considered the father of the inductive method, was a believer in a form of astrology, though he suggested that inquiry was necessary to determine the "just rules of the *Astrologia Sana*." In Shakespeare we find references to the belief in the influence of the stars on human fortunes. In "Henry IV." we find Glendower saying: "At my nativity the front of heaven was full of fiery shapes of burning cressets." Chaucer alludes to the evil effects produced by Saturn:

"... quoth Saturn,
My course, that hath so wide for to turn,
Hath more power than wot any man;
Mine is the drenching in the sea so wan,
Mine is the prison in the dark coat,
Mine is the strangling and hanging by the throat,
The murmur and the churls rebelling."

Each planet had assigned to it a particular metal and a distinctive color, often, no doubt, suggested by its hue.

"Sol gold is, and Luna silver we threpe,
Mars iron, Mercury (quick-) silver we clepe;
Saturn lead, and Jupiter is tin,
And Venus copper, by my faderkin."
("Canon's Yeoman's Tale," Chaucer.)

The colors, by a more or less obvious analogy, were thus assigned to the sun and planets: Yellow to the sun, azure blue to Mercury, red to Mars, black to Saturn, etc. The mediæval astrologers also assigned colors to the twelve signs of the zodiac, and particular districts were ruled over by each sign; thus Ariès ruled over England, France, and Denmark; Taurus over Ireland, Holland, and Persia. The sign Gemini, in particular, was regarded as especially associated with the fortunes (or misfortunes) of London, and, accordingly, the plague, the great fire of London, and the building of London Bridge, were all associated with the position of this sign.

Lilly, the astrologer, is credited with having predicted the occurrence of the plague of 1665 and the great fire of 1666, which latter occurred at the time when part of the sign Gemini was in the ascendant of London. He was questioned by the House of Commons committee appointed to inquire into the cause of the fire, and declared that he had discovered by his art that such an event was to happen, but disclaimed any knowledge as to its date or cause. It is not difficult to understand how some of the influences assigned to the heavenly bodies came to be attributed to them. Thus the sun, from his very evident influence on all terrestrial phenomena, and the moon, from her tidal action, being known to be potent factors, the idea naturally arose that others of the heavenly bodies might have powers as great as, or even greater than, these two over man's destiny. The fiery red color of Mars seemed naturally to associate this planet with "wars and rumors of wars," the dull luster and slow movements of Saturn as naturally indicated misfortune and "Saturnine influence," while the brilliancy of Jupiter and Venus led to their being considered fortunate planets. Mercury, too, always close to the sun and difficult to detect from his rapid motions, betokened volatile and choleric temperament. Yet how the astrologers came to devise the elaborate system by which every planet and each sign has its special influence is by no means easy to say.

In Whewell's opinion the sun, moon, and planets being identified with the gods and goddesses of the Greek and Roman mythology (still surviving in the names of the days of the week), the characters assigned to these deities were transferred to the stars bearing their names. Others there are who, with equal probability, consider that these mythological beliefs were suggested by astrological ideas, the character of Mars from the red color of the planet of that name, the swift-footed Mercury (messenger of the gods) from the rapid movements of the planet, and the supremacy of Jupiter from the greater brightness of that star, and so forth. Nevertheless, though the belief in astrology was very general until quite recent times, there were always clear-minded thinkers who shook themselves free from the popular superstition. Shakespeare, in "King Lear," says: "This is the excellent foppery of the world, that when we are sick in fortune we make guilty of our disasters the sun, moon, and stars, as if we were villains by necessity, fools by heavenly compulsion, knaves, thieves, and treacherous by spherical predominance," etc.

In earlier times Cicero (De Div. II.) reasoned with sound judgment against the belief in astrology. The Emperor Vespasian, when told that his courtiers were discussing the prodigy of the appearance of a comet, said: "This hairy star does not concern me, it menaces rather the King of the Parthians; for he is hairy, but I am bald." Similarly Henry IV. of France, speaking of the astrologers who had foretold his death, is said to have exclaimed: "They will be right some day, and the public will remember the one prediction that has come true better than all the rest that have proved false." Bayle has well said: "The more we study man the more it appears that pride is his ruling passion, and that he affects grandeur even in his misery. Mean and perishable creature that he is, he has been able to persuade himself that he cannot die without disturbing the course of Nature and obliging the heavens to put themselves to fresh expense to light his funeral pomp. Foolish and ridiculous vanity! If we had a just idea of the universe we should soon comprehend that the death or birth of a prince is so insignificant a matter compared to the whole of Nature that it is not an event to stir the heavens."

Yet other writers from time to time allude to the fancies of the astrologers, and though it seems wonderful how so extraordinary a mass of unsupported conjectures and absurd notions can ever have been seriously regarded as science, still we must not look upon the work of these early zealots as altogether vain and wasted.

Just as the fruitless search for the elixir of life and the philosopher's stone by the old alchemists (themselves often astrologers also) laid the foundations of the modern science of chemistry, so by the watchings of the early astrologers was accumulated the material whereon their successors have built the mighty superstructure of modern astronomy. Though it is, and probably will remain, far beyond our power to predict the future course of human affairs, yet the astronomer can determine the future positions of the planets of our system for many ages to come with a precision greater than that of many actual observations. Halley's comet, whose return we have just witnessed, has been detected almost in the position assigned by calculation, after an absence of seventy-four years (of invisibility), during which time it has receded to a distance of more than three thousand millions of miles from the sun. The past and future history of the earth's path round the sun is known for a million of years on either side of the present time. From the observations of the early Chaldean astrologers, and their records of eclipses, the theory of the moon's motion has been, and is being, perfected.

So long as the earth was regarded as the center of the universe, and the sun and stars merely secondary orbs of no great size moving round it, there seemed little to wonder at in men's faith in the teachings of astrology, though even then one might ask how the special influences assigned to the various heavenly bodies, were ascertained to belong to them with such minuteness.

If a man's future career depended only on the position of the heavenly bodies at the time and place of his birth, how did it happen that of two persons both born at the same time and place, one became a beggar, the other a monarch? How different, for instance, the careers of the twin brothers Jacob and Esau, and how different their temperaments! When we consider the earth as it really is, a small planet moving round its central sun together with its fellows, some approaching it in size, others greatly surpassing it, and that there have since been discovered two great planets and a number of moons quite unknown to the early astrologers, it seems hard to conceive our planet to be of such importance that all these other bodies merely exist for its benefit or, rather, for that of its inhabitants. Our sun, too, though all important to us, is only a "cadet" among the hosts of heaven, and there are stars probably as far surpassing it in magnitude as itself surpasses the earth.—Knowledge.

GIGANTIC ABYSS IN THE GREAT NEBULA IN ORION

By EDGAR LUCIEN LARKIN.

THE beneficent patron of astronomy, Mr. John D. Hooker of Los Angeles, Cal., now has on display some wonderful photographs. These were made in the Mount Wilson Observatory, and are of the central regions of the Orion nebula. The original negatives have been greatly enlarged on transparencies. All these are now set in movable frames in an ingenious mechanism for display. Each plate is set in front of sixteen incandescent electric lamps arranged in a square whose dimensions are the same as those of the photograph to be shown, about fifteen inches on a side. The room is darkened, the observer stands before the apparatus at distances of from ten to twenty feet. When the sixteen lamps are lighted, a marvelous effect is obtained. The central portion of the Huyghenian region in the nebula of Orion is the opening of a colossal cavern in the primordial stellar floor. In these pictures the nebula is no longer a flat surface. One peers within cosmic deeps; looks into a chasm before which all powers of imagination are submerged, and feasts the eye with supernal splendors. Every appearance is that of looking in at a door, and to the rear of the cave, deep within glittering nebulosity. The impression made is that the rear walls of this cavern are at an inconceivable distance back from the opening. Mr. Hooker has had all the adjacent regions separately photographed, and shows these in succession round and about the cavern's mouth. Then he again puts this on magnificent display. The impression that one is peering into an abyss is confirmed and strengthened. This chasm as seen in these pictures is the most beautiful object in the possession of man. Pillars, columns, walls, façades, bulwarks, stalactites, and stalagmites are within deeps of deeps. These glow and shine superbly with pearly light.

The nebula has no parallax capable of being measured. Adjacent stars have been observed, those having proper motion and those in revolution around their common centers of gravity. Mass, times, and motions have been made use of to deduce parallaxes. These range between the one three-hundredth and one two-hundredth of one second of arc. To be within bounds, let estimates of the cave's dimensions be made on the basis of one two-hundredth. Then the nebula, if at the same distance of the neighboring stars, at once becomes of colossal magnitude. None is able to begin to think of the dimensions. The central region of the nebula may be taken as of the angular diameter of the moon, or half of one degree. The ragged, torn, and twisted edges of the openings as shown in Mr. Hooker's transparencies for purposes of computation, here will be taken as inclosing a space whose diameter is one-fourth degree or 15 min. Go to the cavern's mouth, turn, and look this way or toward the sun. It would look in a great telescope like the point of a fine needle, or a tiny piece of diamond dust. The earth could not reveal its existence; nor the distance from the earth to the sun, a line 93,000,000 miles in length, viewed from a point at a right angle. It would fill an angle of one two-hundredth part of a second. Then 1 second would have a real length of 18,600,000,000 miles; 1 min. of 1,116,000,000,000 miles; and 15 min. of 16,740,000,000,000, the diameter of this stupendous opening in the stellar floor. The judgment of the eye in this perspective is that the rear of the chasm is three times more distant than the width of the mouth. If so—it actually is and more—then the star-pointed wall is 51,000,000,000,000 miles beyond the open door. This is the distance of the star Sirius. Hundreds of thousands of solar systems like ours could enter and have an abundance of space for free motion.

But the nebula may be more distant than these stars. Then all these dimensions would be largely augmented. The spectrum of this giant mass reveals that it is gaseous. But how does gas emit light, cold light, in frigid space? Light without heat within a body of gas, when space without is at the absolute zero of temperature, is indeed a mystery. A firefly may be able to explain. Celestial photography as now conducted at the Yerkes, Lick, and Wilson observatories is a science whose coming achievements will no doubt be more and ever more astonishing. Light moves with the unthinkable velocity of 186,380 miles per second. With a parallax of one two-hundredth of one second, the time required for light to reach the earth would be close to 600 years, and 1,000 years with one three-hundredth approximately. But what processes are in activity within Orion's cave of unfathomed depths? What suns and worlds are being formed? The second great plate of glass for the new 100-inch mirror presented to the Wilson Observatory by Mr. Hooker has not yet arrived from France; the first having been rejected on account of flaws.

THE THOUSANDTH ANNIVERSARY OF AN ARABIAN UNIVERSITY.

The University of Cairo, the most celebrated of all universities of the Mohammedan world, can boast of having reached its thousandth anniversary. The recent preparation made for the celebration of this event was most noteworthy and shows to all other peoples interested the venerable duration of the scholastic endeavor in the culture of Islam. The very days in which this university was founded are also the date of the origin of the earliest scholastic foundations of Europe, and these, indeed, were, like the celebrated high school of Salerno, for instance, under Arabian influence also. But the University of Cairo provokes keen interest for the further reason that it holds before the eyes of the rest of the world a genuine oriental picture. The seat of this university is to-day in one of the oldest mosques of Cairo, in the magnificently constructed Gami el Azhar, and has been there since the year 988. Indeed, if Arabian erudition once had the power to fructify European mental life, to-day that power seems to have lapsed into the rigor of death long ago. Arabian erudition and the religion of Mohammed are still to-day very nearly identical; the Koran constitutes the sole source of all wisdom, and the schools are held in mosques or adjuncts.

In El Azhar, as one thoroughly skillful observer describes it, the room for prayer of the mosque is also the lecture room of the university. Its floor is covered with mats, and the students enter this holy room only in their bare feet. In the great court in the halls of the sanctuary of the mosque the students sit on the floors, in oriental fashion, in groups around their teachers, while, with shoulders swaying, they learn their lessons with a loud voice or murmur their prayers in accordance with the precepts of Islam. Whenever the word Allah occurs in the Koran, the student must incline his head. The hours of instruction are divided among grammar, religion, law, logic, rhetoric, and declamation of the Koran. Though the general aspect of the instruction is severely religious, great tolerance prevails among the various phases of Islam here seeking together peacefully accommodation and instruction.

The number of students is very significant, to say the least. Six years ago, for instance, it was 8,000, and was composed of Mohammedans from every part of their world. Here the Mohammedan students from India meet those from West Africa, the Turk meets the Persian, and the Arabian the inhabitants of Turkestan. The university is maintained by endowments which are very considerable. Every day more than 5,000 loaves of bread are distributed among the students. Besides they are invited to free tables in restaurants and boarding houses, and there are also lodging houses in which free accommodation is proffered them. The teachers are paid very meagerly, and must depend also on other occupation beyond the schools for their shelter and sustenance. On the other hand, the Sheik ul Islam, the rector of the university, enjoys a very large income. All these circumstances point to an old culture, but they also show us a world that is already rigid from sheer peculiarity; and so the millennial festival of the venerable and celebrated high school of Cairo is far more a festival that regards the past than one that predicts a luminous future.

The Electrical World illustrates an electric heater for drying the matrices used in newspaper printing, and states that the close control of the temperature obtained with electric heating, the rapidity with which the drying is effected, and the technical excellence of the "mats" thus dried, are strong points in favor of the method. Further, as the electric heater can be applied exactly where it is wanted, the room is not heated as with gas or steam, and the electric process is more economical than any other. Printers' electricians on this side of the water may take a hint from this.

SCIENCE NOTES.

The chief center for the manipulation of semi-precious stones in Germany is in the Rhine Province. Both at Oberstein and Idar an important industry has been created, which had its inception in the cutting and dyeing of native agate, the chief deposits of which are now exhausted. At present imported stones are handled chiefly, these coming principally from England and South America. Although agate only was dressed and colored in the early years of this industry, at present all classes of stones are prepared for market. In this, however, the art consists not only in forming the rough stone, but in giving it color as well.

Continuing their researches as to the action of ultra-violet light upon microbes, P. Cernovodeanu and V. Henry of the Paris University recently presented the following account to the Academie des Sciences, analyzing the different physical and chemical factors. Using powerful mercury vapor lamps in quartz tube, the liquid was placed in vessels under the lamp at various distances and samples were taken out at intervals for testing. As the percentage of microbes has little influence, they used emulsion of 10,000 to 100,000 microbes per cubic centimeter, with Bacillus coli, typhus, cholera, dysentery, and others. The microbe destroying action decreases more rapidly than the square of the distance. The 220-volt lamp is for short distances five times as active as the 110-volt lamp, and this is still more noticeable at greater distances. With the larger lamp the time needed to destroy all the coli bacillus is 4 seconds at a distance of 20 centimeters (82 inches). At 10 centimeters it is about one second. Regarding the depth of the liquid, the action is even stronger with a thicker layer, say of 10 inches, than with but one inch. The speed is the same at temperatures of 0 to 55 deg. C., and the effect is produced even with a frozen liquid. Absence of air or oxygen has no effect. It is known that ultra-violet rays tend to form hydroxyl in water, and this latter will destroy microbes. Such is not the effect here, however, as the amount of hydroxyl now formed is infinitesimal and would need to be 400 times as strong in order to destroy the coli bacillus. Different microbes do not show the same sensitiveness, and we have the cholera microbe destroyed in 10 seconds while the tetanus bacillus needs from 20 to 60 seconds. As to wave length, the spectrum of the mercury vapor lamp has a great number of ultra-violet rays which extend as far as 2,224 and lie between this and 3,908. A 1/25-inch glass plate stops off all these after 3,027 and the microbe-destroying effect is now extremely slow, 3 to 5 hours compared with 15 to 20 seconds. A 0.04-inch mica sheet has about the same effect. Protoplasm liquids such as albumen, gelatin, serum, etc., also absorb the rays, and it is the rays which are absorbed by the protoplasm of the cells which have the destroying action.

In the Royal Society's Proceedings, Messrs. B. D. Steele and K. Grant describe two types of micro-balance, the more sensitive one having been constructed with the idea of measuring the amount of radium emanation given off by radium bromide, and is sensitive to 4×10^{-9} grammes. The second type of balance is for the absolute determination in weight up to 1/10 gramme with an accuracy of 10^{-7} grammes. The cases of both balances were made of ¼-inch brass, tinned inside and out. In each case there is also connected a manometer, and a two-way stop-cock, so that communication can be made either with atmosphere or with a Geryk vacuum pump. The beams of both balances were made entirely of quartz in the form of a double triangle, the more sensitive one having a mass of 0.177 gramme. To the beam is fused a concave quartz mirror, and the position of equilibrium is determined by means of the lamp and telescope method. To prevent disturbances due to heating, the Nernst lamp used is placed in a metal case, and the light is passed through a hole in it and through a solution of alum. Irregularities in behavior of the balance due to electrification are entirely obviated by placing on the floor of the balance a little uranium oxide. Before finally adjusting, the beam was boiled in *aqua regia* and washed with distilled water. The central and only knife-edge of the more sensitive balance was ground upon a quartz rod and rests on a polished plate of quartz crystal. Attached to one end of the beam is a small quartz bulb containing air sealed up at a known temperature and pressure. At the other end could be attached a quartz counterpoise of any desired shape. The effective weight of the air contained in the quartz bulb will vary with the pressure of the air inside the case. The principle of the method of measurement consists in measuring the change in pressure of the air in the balance case required to maintain equilibrium when there is a change in weight of the counterpoise. Thus a change in pressure of 1 millimeter in the case was found to correspond to a variation in effective weight of 1.3 $\times 10^{-9}$ grammes, and an alteration of 1 deg. C. at 20 millimeter pressure to a variation of less than 1×10^{-9} grammes. The construction of the second type of balance is also described.

TRADE NOTES AND FORMULÆ.

Cement for Repairing Celluloid.—Dissolve 1 part of camphor in 40 parts of alcohol and add an equal quantity of shellac. The cement must be applied hot and the celluloid articles kept pressed together till it cools.

Disinfectant Paint (Horst).—5 to 10 parts of carbolic acid, 15 parts of manganese, 10 parts chloride of calcium, 10 parts china clay, 20 parts fossil meal, 10 parts of dextrine or gum arabic, and the requisite proportion of water.

Syderamine Cement.—To prepare syderamine cement for steam engines, water conduits, etc., mix and knead equal parts of graphite, iron filings, and unslaked lime with about 20 per cent of linseed-oil varnish or a varnish substitute.

To Paint on Cement with Oil Color.—The freshly applied cement is to be washed twice a day for a week, with fresh water, and after being allowed to dry thoroughly, twice soaked with linseed oil. On cement thus treated, any oil paint will hold.

Cement Composition for Painting Wood.—A good coating for protecting wood against the weather may be made of 1 part of cement, 2 of sand, 1 of pressed-out casein, and ¾ of buttermilk. Stir frequently during use, and make only as much as can be used during the next half hour. Apply as evenly as possible, and not too thick, by means of a brush to the wood, which must be somewhat rough, and repeat the coating.

Harmless Coloring Material for Sugar.—Red: One part each of cochineal, burnt alum, and purified potash and 2 parts of tartar; powder fine and mix. Triturate with water to the quantity and concentration required, leave to stand for a few hours with occasional stirring, and filter. Blue: Take indigocarmine in paste form and enough water to obtain the desired shade of color. Yellow: One part of saffron and 10 of dilute alcohol (7 + 3). After squeezing off the liquid, treat the saffron again with 55 parts of dilute alcohol, and mix the two extracts. For cheaper sugar articles use tincture of turmeric in the proportion of 1 to 5. Green is obtained by mixing yellow and blue; orange, by mixing yellow and red. Aniline colors free from arsenic may also be employed.—Chemisch Technische Spezialitäten.

Washing Putty for Varnished Work.—Grind umber or fawn brown in a mill or on a grindstone with oil varnish and a sufficient quantity of siccative to a thick paint, and work up thoroughly with dry unburned pine soot to the consistence of a soft cement. With this putty, which can be easily and conveniently handled, first fill up all holes and joints; also apply a thin layer with a putty knife here and there to single strips and portions on wheels and wagon frames or on porous wood. The washing now following must be performed before the filler or surfacer becomes dry. Take a small vessel with water in which a few drops of turpentine oil have been poured, dip the finger in it, and wash the treated portions till the surface has a uniformly thick coating. When dry, polish with fine sandpaper and paint with the desired color.

Water-Glass Size.—Dissolve solid potash or soda water-glass in a copper boiler (or a clean iron boiler) by means of boiling water, and to the solution obtained add as much sodium hypochlorite (Javelle water) as may be necessary to destroy the brown color and render the fluid colorless. While the lye is being added it must be quickly stirred. Then pour carefully and slowly into the water-glass sufficient sulphuric acid, diluted with 8 parts of water, to neutralize all the free alkali contained in it, stirring vigorously till flakes of silicic acid begin to be precipitated and to float in the mixture; the addition of the acid is not necessary where there is only a very small quantity of free alkali. Pour the solution of potash or soda water-glass thus obtained into clean boilers of copper or iron and concentrate it by rapid boiling to the required strength, for which, however, there is no definite limit. When cold, keep the mixture in glass bottles till required for use. When necessary, it may be diluted with distilled water for sizing yarn, and a quantity of tallow or soap may be added at the same time, as in sizing with paste.

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